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MECHANICAL ENGINEERING

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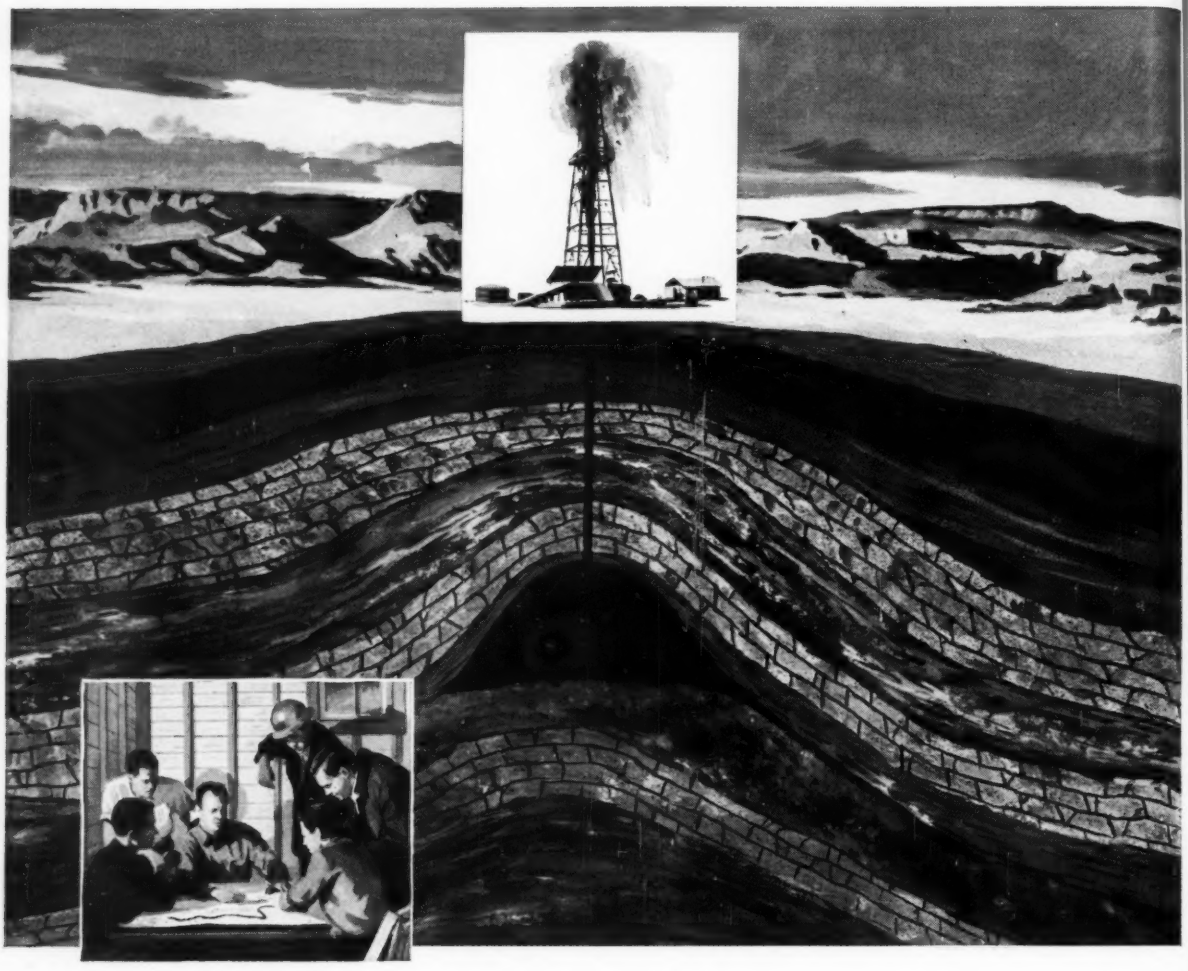

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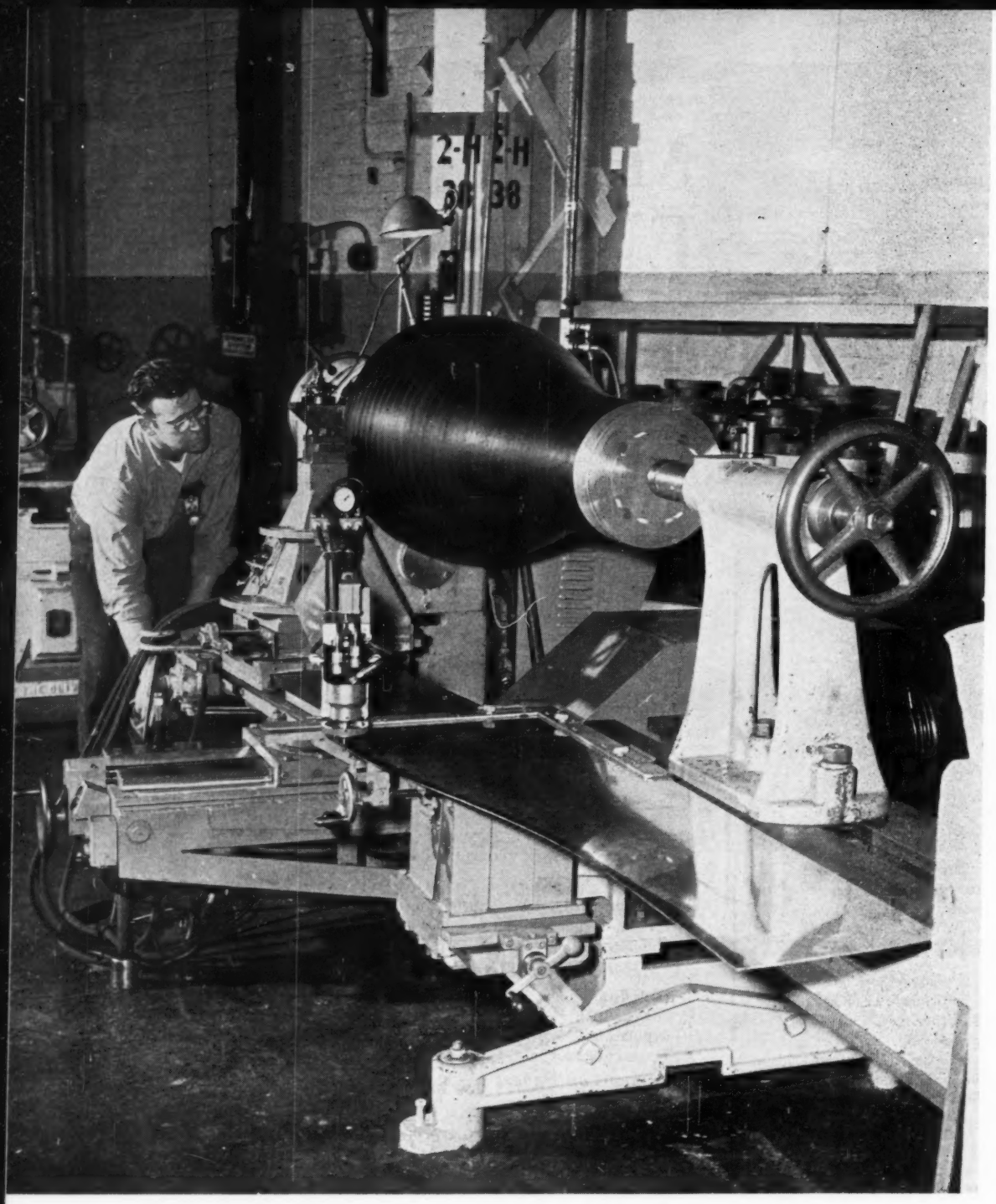

Tracer unit fabricates chuck on spinning lathe . . .

. . .in the sheet metal and extrusions department at the El Segundo, Calif., division of Douglas Aircraft Company, Inc. Developed by Douglas, the unique tracer unit duplicates on a round section the configuration of a flat pattern in one tenth the time necessary by previous methods. In the past, chucks for use on spinning lathes were fabricated in the tooling department on a highly precise machine. A conventional lathe carbide-tip cutter is actuated by a True Trace hydraulic valve from the responses received as the stylus moves along the edge of the template. Tolerances of ± 0.005 in. areachieved by this method. A transit, mounted on the head stock, is used to set accurately the center line of the template in parallel with the axis of the lathe.

Editorial

MECHANICAL ENGINEERING

August, 1955, Vol. 77, No. 8 ◆ George A. Stetson, *Editor*

Prometheus' Heirs

The ceramic-tile plaque of Prometheus, presented at Boston by the Danish Society of Engineers on the occasion of the 75th Anniversary of The American Society of Mechanical Engineers, recalls the Greek legend of the gift of fire, and the consequences thereof, which has engaged the attention of poets, dramatists, and moral philosophers for at least twenty-five-hundred years.

It makes little difference whether or not the legend has any basis of historical fact; whether it is to be understood in the terms of symbolism; whether it is pure fiction, devised as a mystical explanation of how the status of mankind came to be as the Greeks knew it; whether the intelligent person of the fifth century B.C. accepted the story literally or as a brilliantly conceived dramatic spectacle. The questions raised are as old as the inquiring mind of man and as fresh as each new sorrow that lays siege to faith, to justice, and to accepted concepts of good and evil. Or to put it in another light: Although, being familiar with the chemistry of combustion, we may look upon the theft of fire—"hid in a hollow reed" —as an artistic legend, we still find cause for great concern in its modern scientific counterpart, the release of energy from the atom. In the legend also are two great lessons, one noble and the other tragic; the consequences that flow from the service of an individual to all mankind in the advancement of civilization, and the atonement exacted from those who through stubbornness and arrogance fail to comprehend and accept a greater plan than that of their own devising. If the engineer is to accept Prometheus as his patron, let him emulate the example of service to mankind and avoid the tragedy that destroyed the Titan.

Chained to a rock and hurling an agonized defiance at his persecutor, Prometheus recited a long list of his gifts to mortal men whom he had found stupid and brutish, without dwellings or knowledge of the seasons. To them he gave mathematics, the alphabet, spoken language, the tool, and fire. He domesticated the beasts and broke them to the plow and chariot; taught man to sail the seas, the use of medicines and of metal. "All that of art man has, Prometheus gave." And in spite of all this he was punished as "the wrecker of the law."

As heirs of Prometheus, engineers claim credit for much of the material well-being enjoyed by their fellow men today. There is justice in this claim. Few there are who will deny it, providing the claim is not too broad. In our generation as never before engineers are receiving public recognition and substantial rewards. But recognition and rewards are not to be demanded; they must be commanded. It is the right the engineer has won to command these things that is gratifying, not the recognition and the rewards themselves, and this right engineers must be ever alert to defend. They must accept and adhere to the obligations of a profession.

Some 16 years ago, Vannevar Bush delivered an inspiring address on the professional spirit in engineering. In speaking to the question, "Is engineering a profession?" he said: "The important point is this: Does it have a central theme of ministering to the people?" "Professional status," he asserted, "rests in perpetuity not on transient law, not on the cruder machinations of the ancient guilds, not on the exclusive control of those having a special and necessary knowledge, but upon the respect and fundamental support of the people who are served; who only in the long run can insist upon the maintenance of prerogatives, and confer honor, recognition, and special privileges in society upon the members of a profession."

Dr. Bush pointed out that unless engineers are willing to accept "the central theme of the engineers' ministration to society" they will have to resign themselves to the role of "controlled employees and to the disappearance of our independence . . . . . with no higher ideals than to serve as directed and with no greater satisfaction than the securing of an adequate income as one member in the struggle for the profits of an industrial age."

"And to those in the ranks, who may not have seen the light," he concluded, "I would preach the doctrine . . . . . that the path of professional attainment lies open before them, that it is a thorny path that is easily lost sight of among the rocks and rubbish, that it can be adhered to only by sacrifice and by support of those who lead the way, that it leads down into the valley where the sun does not shine, but that it leads at last to the heights. To the heights of true professional attainment, where honor and individual recognition by fellows is the real reward, and where the watchword is that old, old theme, which has never lost its power and which may yet save a sorry world, simple ministration to the people."

The founders of ASME were followers of Prometheus in bestowing gifts on mortal man. But they also upheld the professional ideals set forth by Dr. Bush. We shall be their worthy heirs if we follow where they led the way.

Better Jigs and Fixtures at Less Cost

Ten questions engineers and tool designers should answer before installing any new tools or altering old tools

By Marvin J. Look

Project Engineer
The Singer Manufacturing Company
Bridgeport, Conn.

ONE of the largest expenditures in manufacturing, other than labor, can be the tools ordered to produce parts. This cost presents a problem in the medium and small manufacturing plants. In many of these plants the lot size is small. There are no long runs of the same part. These parts must be manufactured over a period of years in comparatively small quantities per year.

Manufacturers whose production is so varied would find it outside the realm of good business to purchase machinery designed to perform one operation or a series of operations on a specific part. Therefore they must search diligently for new and better ideas in jigs and fixtures. This search, coupled with a review of their present tooling program, must be made in order to provide these manufacturers with the best metalworking tools for the most profitable cost.

The process engineer, for example, is given the assignment of stipulating the methods and tooling to be used in manufacturing a part.

When he determines what must be done to produce the part, this engineer probably searches for a similar part already in production. During his investigation, he uncovers a similar part and finds that the tools assigned are producing the quality desired. He may order similar tools for his assignment and alter some existing tools.

After the tool designer receives the order he may well use the similar tool for an example in designing the new one. If the engineer finds it necessary to by-pass the tool-design section, he may give the order directly to a toolmaker who, in turn, will use the proved tool as a sample. When the tool is completed, it is placed in the hands of a manufacturing department. This department starts a production run and the parts are completed on schedule with minor production problems. There is no reduction in cost. This engineer's company paid the same high price for the new tool as well as for the new part. Yes, engineering solved a problem and helped produce a part, but the correct equation was not used.

The tools as originally designed were advanced for their day. However, we are producing in an era where the tooling situation is more complex with costs prohibitively high and it behooves us to be constantly aware of the changes that must be made.

Everyone realizes that manufacturing processes have progressed from excessive handwork, high costs, and low production to less handwork, more tooling, somewhat lower costs, and more production. How many of us realize that now our processes must progress even further by using automatic, semiautomatic, and easily manipulated tooling?

There are ten basic questions, therefore, that our engineers and tool designers should answer before proceeding with the installation of better tooling.

1 Will the new tool pay for itself? Generally the engineer or tool designer will compile facts in terms of dollars depending on answers to the following questions: What will be the cost of producing the new tool? How much will the factory pay for the use of the new tool? What are the yearly requirements of the part produced? What are we paying for the use of similar tooling? If the tool, on a comparison basis, can pay for itself within one year, or up to five years' time we can probably justify the expenditure. It is not possible to be too thorough. Remember, when your engineers or tool designers initiate the use of a new tool they are signing a check drawn on company funds.

2 What is a jig and what is a fixture? A jig is a movable work-holding device that must be moved to and from the working position by the operator to perform the necessary operation. A fixture is a stationary work-holding device that is clamped, strapped, or bolted to the table of the machine in which the operation is to be performed.

For example, assume a part in which one hole will be drilled. Often a conventional drill jig is ordered and designed. This question should have been asked before the order was placed: "Can a fixture be used in place of a jig?"

In some instances if a drill fixture were used it would eliminate the motion of moving the jig to the spindle and moving the jig from the spindle. By using a fixture your company could save in direct labor costs and possibly a fixture would be less costly to produce. It is probable that a pattern or a casting would not be made. The use of stock cast iron, meehanite, or machine steel sawed to rough shape and finished on important points would suffice. No carbide or hardened-steel inserts are necessary in the legs. It is evident that the choice of proper tooling has a direct bearing on your tool and production costs.

3 How much does it cost to use the component parts usually found in jigs and fixtures? In many of the manufacturing plants of today definite time values have been established for the use of component parts usually found in jigs and fixtures. These parts have been broken down into classifications for easier identification. A quick-acting clamp would be equal to a certain time

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value and a screw-type clamp would be equal to another time value. Leaves, latches, adjustable stops, all clamps, slip bushings, etc., would all have definite time values. It is not absolutely necessary that the engineer and the tool designer know what the time values are but they should have information, by pictorial charts, showing which of these parts are good, better, and best. Of course, it is not always possible to use the best (cheapest) component parts but your engineers and tool designers should strive to create a tool to enable the operator to consume the least amount of time. Not all manufacturers have established time values but observation can establish the component parts that provide the least trouble.

4 What is the comparison in cost of using one jig or fixture or two jigs or fixtures to produce an equal amount of work? In the layout of methods and tooling we must consider getting the job done at the lowest cost. The tendency is to assume that performing as many operations as possible in one tool will provide the desired result. Factual evidence does not always justify this assumption. Considering a specific problem, let us assume a part that will have two drilled holes. Possibly the engineer might decide to drill both holes in a double-leaf jig. By breaking the operation down into elements and comparing one jig with two fixtures set up in an automatic drill press he would determine which type of tool will promote the smallest expenditure. The breakdown in Table 1 will serve to illustrate the point.

Table 1 Comparison of One-Jig and Two-Jig Operation

One-drill jig, time	Elements	Two-drill fixtures, time
0.060	Part handling	0.060
0.060	Load and unload	0.060
0.060	Clean	None (auto flush)
0.060	Open and close leaf	None
0.060	Tighten and loosen clamp	0.060
0.060	Jig to spindle	None
None	Trip feed lever	0.060
0.060	Machine-time total	None
0.060	Jig from spindle	None
0.060	Clean table	None
0.060	Gage	0.060
Total 0.600		Total 0.300

5 How much will it cost to load and unload the tool excluding the clamping? Again we must use the comparison method in relating time values. If these values are not available, observation of the new design or comparable tooling will determine whether or not we have incorporated unnecessary loading restraints.

6 What is being produced by outside suppliers that we can purchase in order to provide jig and fixture component parts that are less costly or can be used to produce a tool that will be less costly to operate? Many manufacturers tend to have their respective toolrooms produce all the parts that are used in a tool. A thorough investigation of the products that can be purchased from outside sources will prove that the average manufacturer cannot hope to meet, or better, suppliers' prices. Why not use these products? Won't they help in reducing your costs?

There is an ever-increasing flow of special costsaving devices appearing on the market today. Manufacturers of these devices maintain constant research programs to produce even better devices. Unfortunately, some manufacturers do not take advantage of these new products. The availability of air, electric, or hydraulically operated devices opens up a new field of tool design. Utilize these products. Considerable savings can be realized.

If your particular company feels that the cost of these products is too high, you can produce your own devices that will clamp, unclamp, and unload automatically by mechanical means. The cost of these homemade devices can be comparatively low or on a par with the cost of your present tooling.

7 How will the new tooling lend itself to standardization? Occasionally, we promote new ideas that seem to be the whole solution to our tooling problem. If proper consideration were given to the differences in the new tool, as compared to every other in the plant, we might hesitate before initiating its use.

Some designs you will consider might appear to be typical "Rube Goldbergs." However, if these ideas do not promote excessive operator training or can lower present training requirements they probably will lend themselves well to standardization.

If your company's program is to embark on better tooling methods, do not use automatic devices and simple designs on a small portion of your tooling and continue to produce the majority to an older well-established design. A full usage of one type, preferably the automatic, semiautomatic, or simple type, will help in standardizing your tooling. This in turn will reduce your toolroom costs and operator training time.

8 Is it necessary to make a tool drawing? There are many manufacturers who continue to disregard the use of a tool-design section. It appears that they would rather place their tool orders directly on the toolroom and let them come up with a usable tool. This is false economy. The manufacturer can obtain new ideas from his tool designers. He can arrive at a better standardization of tooling. He can maintain a permanent record that is usable over and over again for repairs or reordering the same tooling without taking excessive toolmaking time. It will provide him with a complete and more accurate picture of what can be done to make the tool usable for another part. He can maintain better control from engineering.

9 Does the tool as designed meet the requirements of a check list? There are certain basic known facts of tool design that we tend to forget. They can include burr and chip clearance, wiping the burr from the part with the cutter, etc. A check list should be given to your engineers and tool designers. They are probably aware of the basic facts in the check list but it will serve as a constant reminder to them as they plan each job.[1]

10 Should the tool design be altered? Often, after the tool has been designed, someone will come up with a better idea. This, of course, follows the age-old thought that an idea is obsolete the minute it's put on paper. This makes for progress but you must be wary in letting these changes get out of hand. Your first consideration is getting the parts into production. However, if you can prove that the design alteration will reduce costs further and the addition in design time will not make the tool cost prohibitive, go ahead with the change. The cost of the change tends to be lower if you make the alteration before tool production has progressed too far.

[1] There is a good one in "Motion and Time Study Manual," by J. A. Parton, Jr., Conover-Nast Publications, New York, N. Y., 1952, pp. 98-101.

Managerial Control

A General Theory for Designing Industrial Control Systems for Specific Purposes

By J. V. McKenna

Associate Professor of Industrial Engineering, College of Engineering, Syracuse University

PREVENTIVENESS is the essential attribute of a control system. Production control is intended to prevent loss of time, quality control to prevent loss of product through poor workmanship, and cost control to prevent loss of money through inefficient use. Unless the element of preventiveness is present, the system is not a control system. Inspection alone does not constitute quality control; it simply serves to segregate the good from the bad after the bad already has been produced and the loss already sustained. It is only when the prevention of defectives is made possible, e.g., through use of the statistical method, that quality control becomes a reality.

Corrective action should be applied to reduce any loss already encountered. Time lost by failure to maintain production schedules may be recovered to some extent by rescheduling the work, by working extra shifts, or by subcontracting some of the work. Loss resulting from the production of defective assemblies may be reduced by repairing the assemblies, salvaging good components, or selling the units as seconds. These are possibilities for corrective action. They tend to reduce the loss but contribute nothing to the prevention of a similar situation.

Preventive action, designed to prevent recurrence of a problem, is the sine qua non of the control system. To be successful, such action must be based upon complete and intensive analysis of all causal factors entering into the situation. Analytical ability and specialized knowledge of many kinds must be brought to bear upon the problem if the solution is not to produce other, and perhaps more serious, problems. Continuous progress depends in large measure upon the excellence of preventive action.

Controllable and Noncontrollable Elements

A control system may be simple or complex in terms of the number of variables controlled, The simple system is designed to control a primary variable directly. The complex system controls the primary variable only indirectly by controlling a number of secondary component variables.

Industrial systems are generally complex. The cost-control system, for example, controls cost not as a gross item but as a complex of secondary variables. A number of separate controls are designed to control the component elements of cost as discrete entities and these are co-ordinated into a cost-control system. The success of the system depends upon (1) the adequacy of the secondary controls taken individually and (2) the degree of co-ordination achieved.

One of the first problems encountered in the design of a complex control is the identification of the secondary variables of which the primary variable is composed. Whenever this is done, it becomes apparent that not all of these variables can be controlled by management.

The control system is designed to control those elements which reflect efficiency in manufacturing while the elements that are controlled by external forces are largely ignored. The control system is thereby made an instrument for distinguishing between profits which result from fortuitous circumstances and those produced by efficiency in the utilization of company resources.

Control-System Problems

The problems of control in industry are too complex to be handled by a mechanical system. The workman checks his output against standard, the foreman compares actual costs in his own department with standard costs, and the inspector checks actual dimensions against specifications. This is sufficient for the detection of any variances which might exist, but it does not determine the cause of the variance or provide automatically a means of eliminating it. An investigation must be made, the mechanics of the situation studied, and appropriate action taken. Operating problems must be solved on a long-term basis or management will not have the time necessary to plan for the future or develop new opportunities for profit. This requires the collection and analysis of data and the application of human intelligence. It requires a human rather than a mechanical system.

Establishment of Norms

Norms are performance objectives in specific functions of the business enterprise; standard time defines acceptable worker performance, standard cost an ultimate attainable cost goal, and product specifications a desirable level of product quality. The existence of a control system is justified by its ability to enforce its norms. Precision in the determination of norms is of elemental importance in industrial control.

To serve adequately as goals of performance, norms must be objective, reproducible, and stable. Only when they possess these attributes can they be called standards. Thus far it has not been possible to devise standards for all industrial functions. The arbitrary norms, or budgets, currently in use as goals for the control of overhead costs are inadequate by comparison with the objective standards which have been the goal of scientific management

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since Frederick W. Taylor. They are accepted in industry today because real standards have not been developed in these areas.

Servomechanisms are designed to maintain norms which are determined and impressed upon them by an outside agency. This is the case also with management controls; standards for quality control are established by design engineers, those for production control by time-study engineers, and those for cost control by a variety of specialists outside the formally organized cost-control group. This is logical, for industrial control systems are the servants of a management which must accept responsibility for establishing goals for the enterprise.

Control-Group Organization

Generally there are three formally organized control groups in modern industrial establishments. Production-control, quality-control, and cost-control organizations function primarily as sensors, analysts, and advisers. As sensors they collect data on actual performance from a variety of sources. As analysts they summarize and correlate facts and compare actual performance with accepted standards. As advisers they recommend corrective and preventive action based upon their studies.

The personnel associated with a control group are not usually centralized. The control groups have their offices in which all of the planning and much of the analytical work are done, but they also have representatives throughout the plant who are concerned mainly with the collection of data. Whenever complete analysis is possible at their level, these representatives carry out all the activities of sensor and adviser and propose to the foreman a solution to the problems with which they are faced.

From an organizational point of view, control groups are staff. They have no direct authority over the line organization, although it is intended that they should provide control over the activities of the line. Enforcement, one of the essential elements of control, is a line activity because it implies authority. Line officers, making decisions and acting upon the recommendations of the control organization, are acting as the enforcement agents of the system. Under such circumstances, they are an integral part of the system.

As has already been observed, action is required only when abnormal variances occur. The line assumes duties when action is needed and relinquishes them as soon as the need for action is past. Under normal conditions, control is entirely a staff function.

Preventive Action

The appropriateness of preventive action and the speed with which it is applied determine the efficiency of the system. However, speed and appropriateness of action are incompatible when complex problems are encountered. In such circumstances, appropriate action is the result of much deliberation and deliberation requires time. Fortunately, not all problems of control are equally involved, so that while some require much study and cannot be quickly resolved, others can be solved more readily. Speed is governed by the nature of the problem. The control system must be flexible enough that each problem is managed in such a way as to provide appropriate action as quickly as possible.

Complex problems, usually involving the collection and analysis of large quantities of data, must receive adequate study. Such problems are resolved at upper-management levels where recommendations are prepared, decisions made, and instructions issued. The recommendations of the control group are referred to the line at a high level in the organization. The procedure from the time an abnormal variance is detected until action is applied to eliminate it is a long one, well suited to a complex problem but too slow for a simple one.

Simpler problems are resolved more rapidly by referring staff recommendations to the line at progressively lower levels in the organization, Fig. 1. This reduces the losses associated with unfavorable variances and enhances the preventiveness of the system. For this reason provision should be made for detecting variances and taking action at the lowest level in the organization at which valid decisions are possible. "Whenever possible, workmen should be provided with the tools to check their own performance with regard to both quality and quantity."[1] They should then be held responsible for observing their own deficiencies and taking corrective action themselves or seeking competent assistance if necessary. Thus the fact that the foreman did not observe that the production of a certain workman was not up to schedule is no excuse for the workman to continue to produce at an inefficient rate. Likewise, the fact that the inspector did not examine this work is no excuse for the machinist to go on turning out defective work. Whenever a problem must be referred to higher-management levels, corrective action will be delayed and losses mount; the greater the delay, the higher the costs. Juran states it as follows: "The best plan is to avoid the whole process of seeking aid at higher levels by taking proper action at the site of the problem at the time it is discovered."[2]

Control at Foreman Level

For the most efficient operation of the control system, the foreman should control operations in his own department. Serious or prolonged problems should be referred to the proper control group in a formal report. These reports are the basic communications of the control system. They should be designed to promote maximum speed in the operation of the system.

To be most effective, these reports should be comparative. Actual performance should be compared with standard. Variances should appear as differences between the two. It is important that standard performance should appear in the report along with the variance, as the significance of the variance can be determined only by comparison with expected performance. Variances call for explanation on the part of the foreman and these should be considered an integral part of the report. Reports should be easy to make, read, and interpret and they should be routine and frequent so that serious situations may be adjusted before extensive loss occurs.

Adequate control is one of the essentials of good management. At the present time a number of control systems are used, each of which is designed to prevent

[1] "Quality Control Handbook," by J. M. Juran, McGraw-Hill Book Company, Inc., New York, N. Y., 1951, p. 148.
[2] Ibid., p. 181.

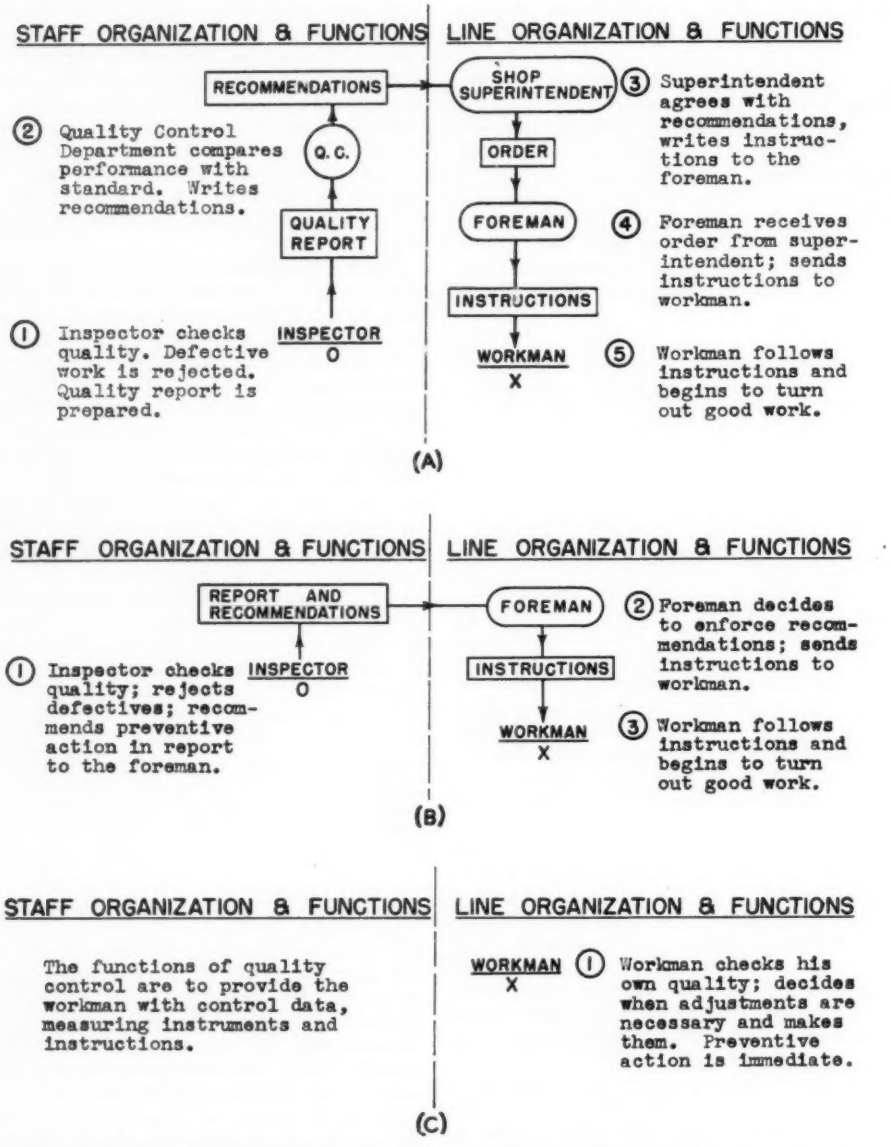
STAFF ORGANIZATION & FUNCTIONS
LINE ORGANIZATION & FUNCTIONS
RECOMMENDATIONS
SHOP SUPERINTENDENT
3 Superintendent agrees with recommendations, writes instructions to the foreman.
2 Quality Control Department compares performance with standard. Writes recommendations.
Q.C.
ORDER
QUALITY REPORT
FOREMAN
4 Foreman receives order from superintendent; sends instructions to workman.
INSTRUCTIONS
1 Inspector checks quality. Defective work is rejected. Quality report is prepared.
INSPECTOR O
WORKMAN X
5 Workman follows instructions and begins to turn out good work.
(A)
STAFF ORGANIZATION & FUNCTIONS
LINE ORGANIZATION & FUNCTIONS
REPORT AND RECOMMENDATIONS
FOREMAN
2 Foreman decides to enforce recommendations; sends instructions to workman.
1 Inspector checks quality; rejects defectives; recommends preventive action in report to the foreman.
INSPECTOR O
INSTRUCTIONS
WORKMAN X
3 Workman follows instructions and begins to turn out good work.
(B)
STAFF ORGANIZATION & FUNCTIONS
LINE ORGANIZATION & FUNCTIONS
The functions of quality control are to provide the workman with control data, measuring instruments and instructions.
WORKMAN X
1 Workman checks his own quality; decides when adjustments are necessary and makes them. Preventive action is immediate.
(C)

Fig. 1 Relation of staff organization and functions to line organization and functions in resolving control problems. (*A*), Control for complex problems; (*B*), Control for simpler problems; (*C*), On-the-spot control.

serious loss in one specific manufacturing activity. The foregoing discussion indicates that these control systems are fundamentally alike. One might logically inquire why they are not then combined into one over-all control system. One of the reasons this has not been done is that they have been developed at different times and by different people. An even more important reason, however, is that scientific standards have not been devised in all of the areas where control is desired. The systems which are based on standards are more sound and more satisfactory in practice than those based on arbitrary norms so that there seems to be no benefit in combining the two types.

Progress toward a unified control system depends upon the development of compatible systems; that is, systems which are capable of being combined.

Progress toward the development of a unified control system demands that each of the specific controls be designed according to a common basic theory and that arbitrary norms be replaced by scientific ones. The theory just presented is the basis of most modern systems. It appears satisfactory in that it is capable of yielding compatible systems. The problem of developing scientific norms for all the activities which require control is complex and satisfactory answers are as yet beyond the horizon of current research.

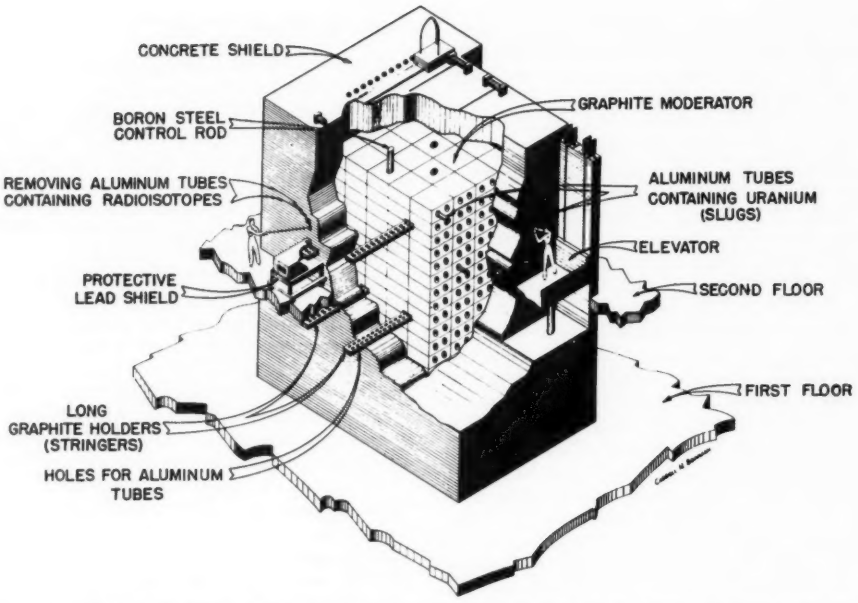

Fig. 1 Simplified schematic of a uranium reactor using graphite as the moderator (Courtesy U. S. Atomic Energy Commission, Oak Ridge, Tenn.)

Powder Metallurgy—

Its Role in the Design of Nuclear-Power Reactors

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THERE are many material problems involved in the design of nuclear-power reactors (1).[3] For example, take a nuclear reactor using graphite as the moderator, Fig. 1. The graphite blocks are pierced by a symmetrical array of aluminum tubes which act as coolant pipes. The uranium metal-fuel slugs in suitable containers are loaded into the aluminum tubes. Boron-steel control rods penetrate the core and regulate the neutron density. The core is surrounded by the concrete reflector and biological shield. Holes penetrating the core make possible the production of radioisotopes.

A gas-cooled reactor proposed by the Commonwealth Edison Company of Chicago will contain uranium fuel elements with an internal temperature somewhere between 1000 and 1300 F. Helium is proposed as the coolant with an inlet temperature near 450 F and an outlet temperature in the range of 700 to 750 F, assuming a gas flow of approximately 3.27×10^6 lb per hr (2).

Another reactor proposed by Dow-Detroit Edison Company is designed for a liquid-metal coolant such as sodium. The coolant temperature could be somewhere between 800 and 1100 F. A similar, but not identical, reactor has been proposed by the Monsanto Chemical Group.

The reactor designed by the Pacific Gas and Electric Company uses water as a coolant. All the reactor elements, the fuel, coolant, coolant transportation system, the moderator, any internal structural materials, and the reactor-control elements, will necessarily operate at elevated temperatures.

The metallurgical problems in the design of reactors are, therefore, characterized by the behavior of metals, and the reactions between metals, at elevated temperatures and under irradiation (3). These problems include: (*a*) mechanical behavior at elevated temperatures; (*b*) corrosion behavior; (*c*) thermal conduction; (*d*) heat transfer; (*e*) radiation damage.

There are, of course, many more metallurgical problems connected with the neutron-absorption cross sections of the reactor materials and the formation of radioactive isotopes in the removable components.

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[1] Manager of Engineering.
[2] Engineering Specialist.
[3] Numbers in parentheses refer to the Bibliography at the end of the paper.

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The mechanical-metallurgical problems concern practically all the metal components in the reactor, those for structural purposes as well as operating parts, including the fuel metal, the coolant, and others.

Fuel Metal. The basic difference between the fuel metal and other common metal parts at elevated temperatures can best be described by the difference in the direction of heat flow. Common metals during heating usually receive the heat from the outside, whereas the fuel metals produce the heat internally from fission. Whereas common metals can be heated from the outside to a perfectly uniform temperature throughout, the fuel metal producing the heat under irradiation will always have a higher temperature inside than outside. The temperature gradient between the center of the fuel element and the surface is a function of many variables, the most important ones being; neutron flux; shape and physical dimensions of the element; type and circulation speed of the coolant; thermal conductivity of the fuel material.

Any mechanical calculations concerning fuel elements have to take this temperature gradient and, therefore, the stresses caused by this gradient, into consideration. These stresses make predictions of the behavior of the elements difficult since creep of the fuel metal is affected.

In addition, these stresses are of prime importance in all problems concerning the bond between a fuel-element metal and the protective fuel-element cladding. Any high-temperature reactor utilizing metallic fuel elements requires a reliable bond between fuel metals and cladding, especially for heat-conduction reasons. The cladding metal has to be chosen carefully; it must have a low neutron-absorption cross section for reasons of neutron economy, its thermal expansion must match that of the fuel metal to a certain extent, and it must resist corrosion under the operating conditions. Inasmuch as the fuel elements operate at elevated temperature, care must be taken to avoid diffusion of the fuel metal into and through the cladding during operation.

Complicated mechanical problems will be encountered when the coolant is a liquid metal; however, these problems are not pertinent to the powder-metallurgical aspects with which this paper is concerned.

Corrosion. Most of the corrosion problems in a nuclear-power reactor are related to the type, temperature, and pressure of the coolant. There is a general agreement among reactor designers that the fuel material should be placed in a sealed container in order to prevent corrosion and erosion by the coolant. However, even when the nature of the coolant does not promote corrosion, as is true in the case of argon, it will be necessary to clad the fuel material in order to prevent radioactive fission fragments from entering the coolant. Some of the metals considered for cladding materials or for coolant pipe lines have been developed only recently, and little is known about their corrosion behavior. Where liquid metals are used as coolants, there is danger that they may react with the cladding material.

Corrosion in a nuclear-power reactor may take place at the following points: Between fuel cladding and coolant or between fuel metal and the coolant in case of imperfect cladding.

Static corrosion tests are not sufficient for testing the materials under consideration inasmuch as the coolant in the reactor circulates at a fairly high speed and under pressure. Corrosion problems are difficult in cases where welded joints must be used, as corrosion may be enhanced by alloys formed during the welding procedure.

Radiation Effect

Radiation effect is probably one of the most important problems in the reactor design (4, 5, 6, 7). Metallurgists and solid-state physicists are still searching for correct theoretical explanations for the phenomena observed.

During the past few years, it has been shown that the physical properties of many materials change under irradiation; these changes vary with the type, density, and duration of radiation, and also with the type and structure of the material. It is fairly well agreed at present that organic compounds are affected by beta, gamma, and neutron radiation, and that the disturbances in these materials can be explained by ionization. Metals, however, being good electrical conductors, seem to be affected chiefly by neutrons. Some of the experimentally observed disturbances in metals can be explained and correlated on the basis of a lattice-vacancy picture, which considers displacements of atoms from their normal crystal lattice positions. It is understandable that the kinetic energy of a fast neutron is high enough to displace atoms during an elastic collision and thus to disrupt the material. As a result of such collisions, we may expect the creation of a number of lattice vacancies, and the removed atoms also may displace still other atoms from the lattice. It is also possible that these displaced atoms excite lattice vibrations of a mean energy corresponding to a temperature higher than the average temperature of the material (5).

It is interesting to note that most of the changes in the physical properties of metals that occur on exposure to neutron radiation resemble the changes occurring as a result of cold-working, although the mechanisms of these two types of change are of an entirely different nature. It also appears that a correlation exists between the degree of cold-working, the heat-treatment of a metal, and the extent of changes under neutron radiation (7).

Fig. 2 shows the effect of irradiation on the tensile strength and yield strength of several metals. From this figure, one can see that especially the yield strength of some metals increases considerably under irradiation and that the increase for nickel is especially high, whereas the increase in yield strength for zirconium is considerably less.

Fig. 3 shows the effects of irradiation on the hardness of the same metals. Radiation increases the hardness very little in hardened metals but considerably more in annealed metals (7). It seems that the lattice dislocations and defects produced by hardening lower the effect of radiation substantially, especially when compared with the radiation effects on annealed metals which are characterized by more undisturbed or at least by less-distorted lattices.

The Role of Powder Metallurgy

Metals prepared by powder metallurgy differ in many ways from metals made by conventional methods.

Crystal Lattices in Powder Metallurgy. Metal powders can be fabricated by several mechanical, chemical, or electrochemical methods. According to the method of fabrication, the powder particles differ in shape, size, and structure.

Any powder particle is characterized by the high ratio of its surface area to its mass or volume. This is an important feature with respect to the particle structure, in-

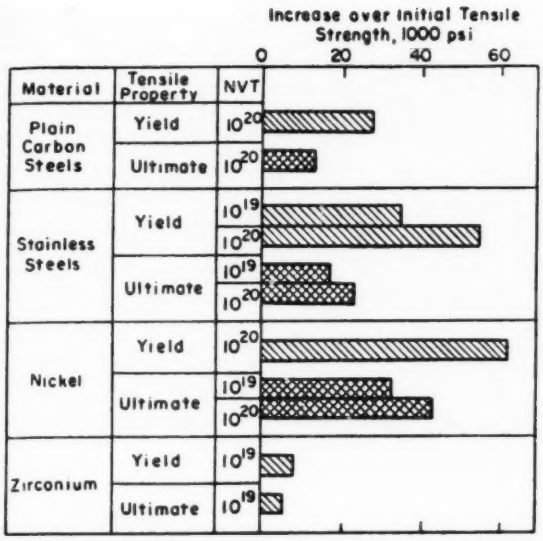

Fig. 2 Effect of irradiation on tensile strength of some metals (Courtesy Reinhold Publishing Company)

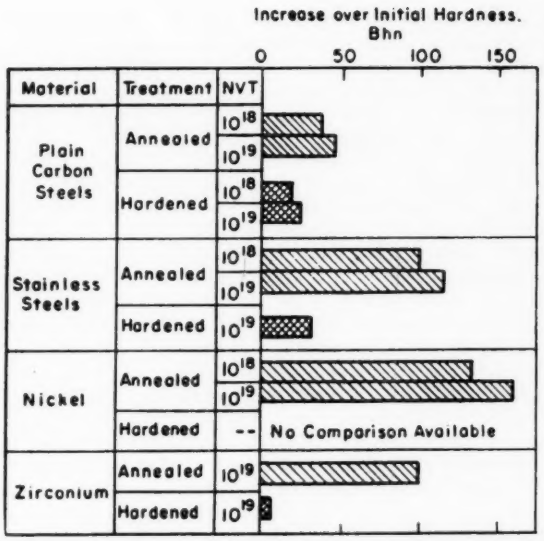

Fig. 3 Effect of irradiation on hardness of some metals (Courtesy Reinhold Publishing Company)

asmuch as the surface crystal lattices are usually different from the body lattices; they show a large amount of lattice vacancies, dislocations, or other disturbances, so that one may consider these surface lattices as highly disordered. It has been shown before that the radiation effect in a material is closely connected with the degree of disorder in the structure and that a material with higher degree of disorder in the crystal lattices is more resistant to radiation effect than when characterized by ordered lattices.

The lattice distortions in the metal powders progress further during compacting under pressures which vary between 5 and 50 tsi, but which are still much greater in the contact areas where the metal-powder particles touch each other. During the next step in powder metallurgy, i.e., sintering, the lattices rearrange to a certain extent but very seldom end up in ordered structures, although by some heat-treatment after sintering conditions, the lattice structures may change to ordered ones. The disordered lattices resulting from the powder-metallurgical processing may make a material more resistant to radiation effect and this is definitely one advantage powder metallurgy has to offer as a method for fabricating materials for nuclear-power reactors.

Grain Structure in Powder-Metallurgy Products. It must be mentioned that the grain growth in powder-metallurgy products during sintering is different from the normal grain growth in conventionally fabricated metals treated under similar heating conditions. This matter is of greatest importance and will be discussed in more detail.

The equations governing grain growth in metals are well known. One distinguishes between continuous grain growth and grain growth by cold-work and recrystallization. The higher the degree of cold-work, the more nuclei are formed for recrystallization and, therefore, the smaller the grains are in the structure under development. Grain growth can be hindered by the addition of impurities to the metal. This inhibits grain growth or at least decreases considerably the rate of grain growth. The compact pressed from metal powders contains a large amount of highly cold-worked powder particles. Between the powder particles, there are voids, or holes, which take approximately 10 to 30 per cent of the compact volume. Because of the high degree of cold-work in the powder particles, even before but especially after compacting, a large number of nuclei for recrystallization are formed, which leads, in general, to small grain sizes. Besides, one has to consider further that the voids between powder particles act in a manner similar to impurities; that is, they hinder or delay the grain growth during sintering. This reduction of grain growth during sintering is especially effective during the earlier stages of sintering. As sintering progresses, the voids become smaller and most of them finally disappear. Both facts—the high degree of cold-work in powder particles and the presence of voids—have the effect that powder-metallurgy products are usually characterized by smaller grains in the structure, although the grain sizes can be increased by a heat-treatment above sintering conditions, following the actual sintering operation.

Alloys by Powder Metallurgy. Powder metallurgy offers, also, other advantages with respect to the development of reactor materials. It is well known among nuclear engineers that certain alloys made from fissionable materials with small alloying additions are more favorable with respect to radiation effect and corrosion than the pure fissionable material, although the mechanisms causing these effects are not fully understood as yet. Alloys can be prepared by conventional melting processes in liquid-state reactions or they can be made by powder metallurgy in solid-state reactions. The end product may differ in grain size; however, this may not have any extensive effect on the corrosion resistance of the alloy.

The preparation of certain alloys by powder metallurgy offers some advantages, especially with respect to alloys made from very heavy metals, such as uranium, and very light metals. Ordinary melting of two components with quite a difference in density frequently results in segregation of the two components, and one or even more

remelting steps may have to be added in order to obtain a homogeneous alloy structure. Remelting, however, like any other long-term, high-temperature process, involves the danger that the metals may pick up definitely undesirable amounts of gaseous impurities. Mixing the two alloying components in the form of powder particles to a high degree of uniformity offers no difficulty, and any subsequent compacting or sintering operation does not disturb the homogeneity of the mixture. Although the large total surface area of the powder particles would usually permit the pickup of gases, powder-metallurgy sintering usually occurs at temperatures far below the melting temperature of the metallic components, and this low-temperature process lowers the possibilities of picking up gaseous impurities. All this indicates that alloys prepared by powder metallurgy may be very useful and offer advantages compared with conventionally prepared alloys in the fabrication of components for nuclear reactors, where impurities play such an important role.

Metallic Compounds and Cermets. It is a well-known fact that certain combinations of metals, which do not form an alloy, can be made by powder-metallurgy methods. These metal combinations are known as compound metals, such as tungsten-copper or molybdenum-silver combinations as used for electrical contacts. In these compound metals, one metallic component is present, either in the form of discrete particles within the matrix of a second component, or in the form of a metallic framework interwoven with another metallic framework.

The materials known as cermets—combinations of metallic and nonmetallic components—are similar to the compound metals and cannot be made by any other method than by powder metallurgy. The development of these cermets is usually directed toward products for high-temperature purposes, such as parts for gas turbines or jet-propulsion engines, and the ceramic components are usually carbides, borides, or other metal compounds bonded together by metals such as nickel, copper, etc. These cermets may offer certain advantages when developed for nuclear-engineering purposes.

The solid-fuel element developed as a cermet could play an important part in any reactor design, and powder-metallurgy fabrication methods are required for these types of materials.

Bonding for Heat-Transfer Purposes. It was stated previously that certain reactor parts, such as fuel elements, must be clad by another metal in order to prevent corrosion under reactor operating conditions. The "cladding" sometimes has to be well bonded in order to create best conditions for heat transfer which, as pointed out, plays an important role in several reactor components.

A perfect metallurgical or diffusion bond between the metal part to be protected and the protecting metallic cladding, which prevents corrosion, is very desirable in many cases, and powder metallurgy offers some advantages in this respect. Diffusion of one metal into another metal usually requires high temperature or long-term treatment at lower temperatures; both these conditions are not always in the range of possibility for production operations. In order to lower the diffusion temperature or decrease the diffusion time, the metals should have high surface activity, which usually results in an increased diffusion rate. Metal-powder particles, on account of their high curvature and their large number of lattice defects, usually diffuse at lower temperatures, and within a shorter time, than cast metallic bodies. Fig. 4 shows schematically the rate of diffusion.

From this schematic, one can recognize that minimum diffusion occurs between cast metals and that the fastest diffusion rate occurs between metal powders in the unsintered state. Experience has shown that sintered metals diffuse easier than cast metals. This fact makes powder metallurgy interesting with respect to the cladding problems in the development of reactor components, inasmuch as conditions can be created which result in perfect heat transfer while minimizing other deleterious effects.

The Powder Metallurgy of Beryllium, Thorium, Uranium, and Zirconium. Beryllium (8), being a very brittle metal, can be prepared in powder form by milling and grinding of the solid material in neutral atmospheres. Uranium (9), thorium (9), and zirconium (10), which are not brittle, cannot be ground so easily; however, they form brittle hydrides when exposed to hydrogen at certain temperatures which are approximately 225 C for uranium (9), 750 C for thorium (9), and 400 C for zirconium (10). Uranium hydride, in itself, is a fine powder, whereas the hydrides of thorium and zirconium are solid materials of a high degree of brittleness which can be ground to desirable particle sizes. The decomposition of these hydride powders occurs in vacuo at elevated temperatures, and the metal powders formed in this way are applicable to any powder-metallurgical process.

Hazards in Handling Powders. One has to keep in mind, however, that handling of these powders is not so easy as that of copper, iron, or any other ordinary metal powder. Beryllium, in powder form, is highly toxic; zirconium, in fine particle sizes, is highly pyrophoric; and the powders of uranium and thorium are both toxic and pyrophoric. Handling of these powders has to be done, therefore, with greatest care. Dry boxes, such as shown in Fig. 5, for manipulating these powders have been well developed by the skill of mechanical engineers and permit safe handling of these dangerous materials.

Compactibility. The compactibility of the four powders is quite different; it depends, to a certain extent, on the particle sizes of the respective powders; to a larger extent on the purity; and to the largest extent on the plasticity of the particle material. If generalizations are permitted, we may state that among the four powders, thorium compacts to the highest per cent theoretical density and uranium powder to the lowest density; zirconium and beryllium are just in-between, as shown in Fig. 6.

Sintering. Sintering of the four powders subsequent to compacting is quite different. Zirconium has been

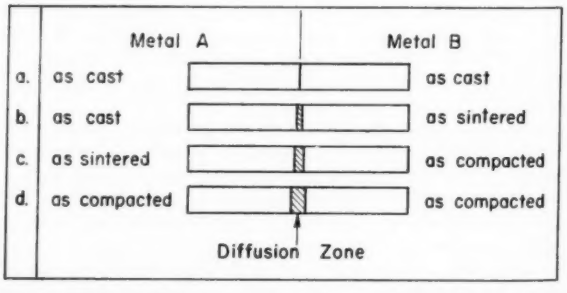

Fig. 4 Diffusion between two metals, A and B, under constant temperature, time, and pressure conditions as a function of their method of preparation

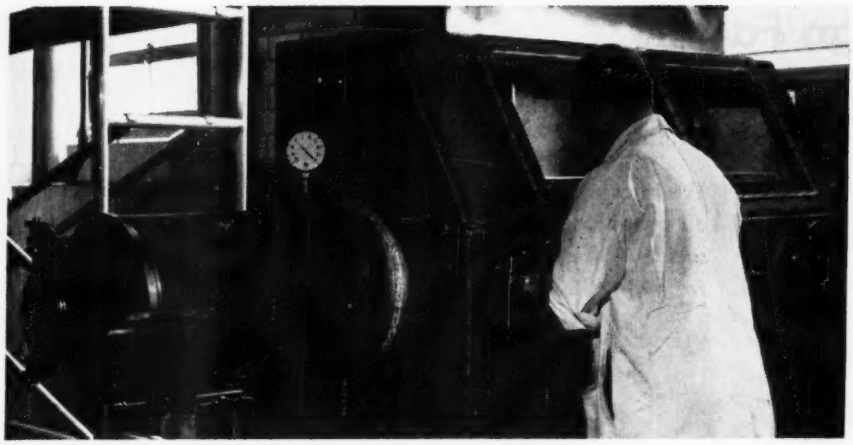

Fig. 5 Dry box for handling toxic and pyrophoric metal powders in protective atmospheres

found to be an almost ideal material for powder metallurgy, inasmuch as it sinters to high density at temperatures far below its melting point. Thorium also densifies at fairly low temperatures to practically theoretical density, whereas uranium and beryllium start to densify only at fairly high sintering temperatures, approximately 85 per cent of the melting temperatures of these metals. Beryllium and zirconium are most interesting metals from the standpoint of powder-metallurgy sintering.

Zirconium powder, as discussed before, is made by decomposition of zirconium hydride. Zirconium-hydride powder cannot be compacted as well as the zirconium powder but it compacts to such a degree of density that the compact is strong enough to be handled and sintered. During sintering in vacuo, the zirconium-hydride compact decomposes and the zirconium particles formed in this way start sintering in the presence of atomic hydrogen. Under these conditions, the extremely fine zirconium particles in the presence of atomic hydrogen start bonding at very low temperatures and sinter to a very high density, also at relatively low temperatures. In this way, complete densification can be reached at temperatures of approximately 650 C below the melting point of zirconium.

The method of pressing a metal-compound powder, such as a hydride, and ending up with a completely densified, sintered-metal product is quite a novel process and will probably find many further applications. The powder metallurgy of beryllium is also interesting, but from quite a different standpoint. Beryllium must be sintered in a nonoxidizing atmosphere such as argon or vacuum. It densifies fairly uniformly in both of the mentioned sintering atmospheres, but it does not reach full density. There is, however, a big difference between the argon and vacuum-sintered beryllium. Whereas the argon-sintered beryllium is as brittle as described in the literature, the vacuum-sintered beryllium shows some ductility, inasmuch as it can be cold-rolled approximately 10 per cent, annealed, and again cold-rolled. This fact can be explained as follows: During vacuum sintering, evaporation of beryllium starts at fairly low temperatures and acts as an additional sintering mechanism, resulting in grains of certain sizes and shapes which favorably affect the ductility of the material. Evaporation, as a mechanism of sintering, is also a phenomenon which deserves further investigation and study with respect to various metals.

Fig. 6 shows further that all four metals can be densified by cold-pressing and subsequent sintering. The powder-metallurgical method of hot-compacting can also be applied to the four metals and results in complete densification of these materials, similar to any common metal. Needless to say, pressing and sintering or hot-compacting of these toxic and pyrophoric powders has to be done with greatest care in the presence of protective atmospheres such as argon or helium.

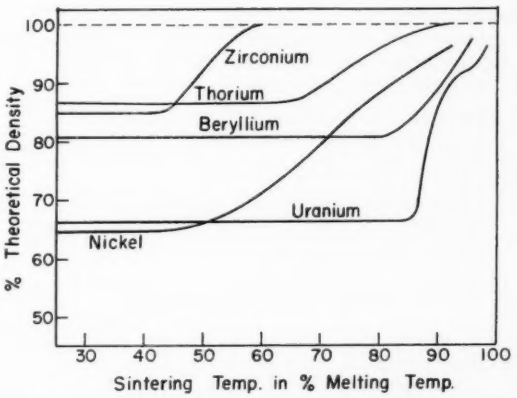

Fig. 6 Densification of nickel, zirconium, beryllium, thorium, and uranium powders, compacted at 50 tsi, as a function of sintering temperature

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Weather Design Factors in Air Conditioning

Weather contributes 80–90 per cent of the load for residence air conditioning; 50–60 per cent for commercial applications, such as offices, department stores, theaters, and the like; and from 0–100 per cent for conditioning an industrial plant

By John Everetts, Jr.

Office of Charles S. Leopold, Philadelphia, Pa.

Air conditioning for comfort is designed primarily to minimize the discomforts surrounding man in an enclosed environment. These discomforts are caused by the weather and internal sources of heat. There are five major sources of heat which cause discomfort and make up the cooling-load requirements:

1 Dry-bulb temperature of the atmosphere
2 Heat radiated from the sun
3 Heat and moisture liberated from people
4 Heat from lights and other miscellaneous sources
5 Wet-bulb temperature of atmosphere

To illustrate the relationship of the various heat-producing factors involved in an air-conditioning load, each of the foregoing heat sources will be discussed separately.

Dry-Bulb Temperature

The dry-bulb temperature of the air is the temperature recorded by the Weather Bureau. This temperature acts as a potential to cause a flow of heat into a structure in which the temperature is maintained at a lower level. This flow of heat is called the "transmission load" or the heat gain produced by a difference in dry-bulb temperature causing a flow of heat through a structure of known resistance. Therefore the variation of dry-bulb temperature is important in proportion to the extent of the transmission load. Fig. 1 shows the variation of the dry-bulb temperature in relation to the per cent of the total hours from June to September, inclusive, on a 24-hr basis up to 20 per cent of the time.

The maximum temperature (0 per cent of time) shows 110 for Huron, 101 for New York, and 97 for New Orleans. The trend of dry-bulb temperatures for the remainder of the time indicates the relative importance of this factor in air-conditioning design. Eight per cent of the time Huron and New Orleans have the same dry-bulb temperature of 89 F while New York is a cool 85 F. At 20 per cent of the time, or in excess thereof, New Orleans is 87, Huron 83.5, and New York 80 F.

Fig. 2 shows the relationship of the transmission load for a typical application compared for the three cities and based upon the variation in total hours of an arbitrary cooling season. Huron, with a maximum transmission load of 710,000 Btu per hr, drops off 75 per cent to 175,000 Btu per hr above 20 per cent of the time. New Orleans, on the other hand, drops from a high of 430,000 Btu per hr to only 245,000 Btu per hr, or a reduction of only 43 per cent. New York shows a reduction of 520,000 Btu, to 100,000 Btu, or a reduction of 81 per cent above 20 per cent of the time. These values are important in relation to the importance of the transmission load to the total load. This varies with the type of building, application, and zoning of the air-conditioned areas and are functions of design practice.

The heat radiated from the sun is transmitted to an

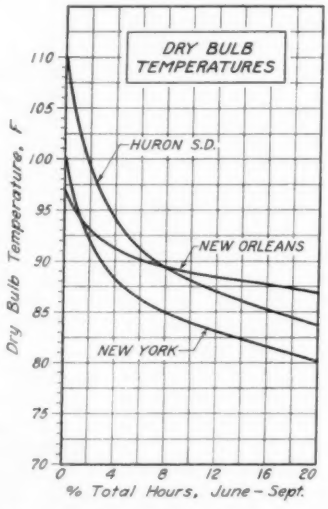

Fig. 1 Dry-bulb variations related to per cent of total hours, June through September

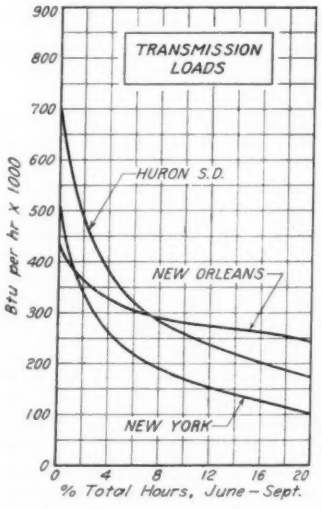

Fig. 2 Transmission-load relations for typical applications for three cities

Contributed by the Process Industries Division and presented at the Annual Meeting, New York, N. Y., November 28–December 3, 1954, of The American Society of Mechanical Engineers.

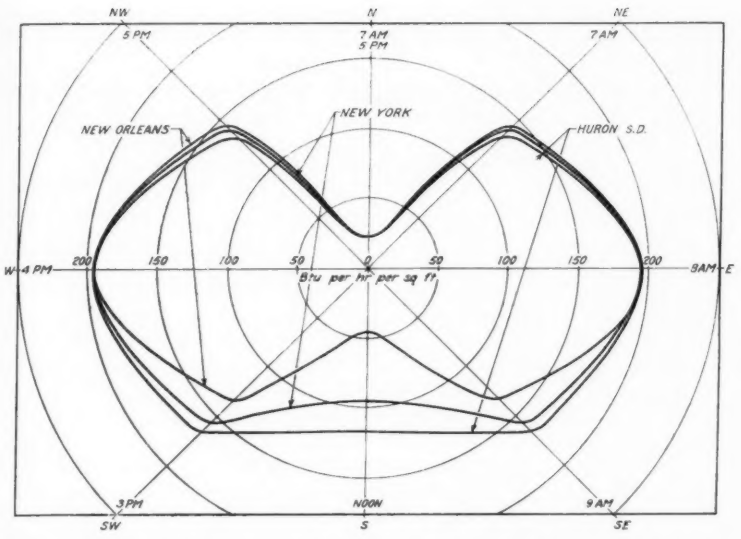

Fig. 3 Maximum instantaneous solar-heat gain through single glass August 1 for New Orleans, New York, and Huron, S. D.

enclosed space by direct radiation through glass and by transmission through other parts of the structure by raising the surface temperature. The transmission through glass is so high compared to that through the structure that the structure load is usually neglected in calculating the total load. Fig. 3 shows the maximum instantaneous solar-heat gain through single glass taken on August 1. It is interesting to note that for the three cities shown (New Orleans latitude 30°; New York latitude 41°; and Huron latitude 45°) the solar load for the West, Northwest, North, Northeast, and East shows little variation, while the values for the Southeast, South, and Southwest show a range from 47 Btu in the south for New Orleans to 134 Btu in the south for Huron, or approximately three times the solar load on a south glass exposure.

While the solar-heat gain is a small proportion of the total load in most cases, the full load is carried by only one zone at a time, such as the east in the morning, south at noon, and the west in the afternoon. As the zones of a building extend only 15 to 20 ft in from the perimeter wall, then the solar load becomes an appreciable part of that particular zone load. Considerable care should be taken in the selection of solar-load values and also in the use of diversity factors applied to shading devices.

The intensity of the solar radiation will vary with atmospheric impurities, orientation, and latitude. Values will be lower in industrial areas where smoke and dust are more prevalent than in areas where the air is relatively clean. The effect of orientation and latitude are illustrated in Fig. 3. The greatest loads are in the east in the morning and the west in the afternoon. The south load varies considerably, as mentioned previously, with latitude. Solar radiation on the north will rise rapidly with a small shift to the northeast or northwest. The diffuse sky radiation, in addition to the instantaneous solar radiation, is also important and applies with equal intensity to any orientation in view of the sky.

Shading devices should be considered with caution. Venetian blinds are seldom fully drawn except to block direct sunlight reaching an individual.

Solar-heat-gain values may be in terms of direct heat flow or as an equivalent temperature difference related to various types of construction of walls and roofs. Textbooks and data books show either and some show both.

Heat and Moisture From People

So long as the ambient-air temperature and room surfaces are maintained below body temperature and the relative humidity below 100 per cent, a person will release heat by radiation and convection, and moisture by evaporation. Moisture loss by perspiration occurs when a person is subjected to a temperature and relative humidity well above that required for optimum comfort. Assuming a maintained temperature of 75 F and a relative humidity of 50 per cent, each average person will release approximately 250 Btu per hr of sensible heat by radiation and convection and 150 Btu per hr of latent heat by evaporation.

Based upon a fixed occupancy, this load becomes a constant value and does not vary with the weather conditions or geographical location.

Heat From Lights

Luminaires release heat by radiation, convection, and conduction and the total heat release is equal to 3415 Btu per hr per kilowatt input. A large part of this heat loss is by radiation which goes into storage but is later released as convection to the air; therefore the full value of the lighting load should be applied to the air-conditioning load except in special cases where the luminaires are recessed in specially ventilated plenums.

Wet-Bulb Temperature

The wet-bulb temperature of the atmosphere imposes the greatest single load and the greatest variation in load of an air-conditioning system.

Fig. 4 shows the wet-bulb temperature variation for New Orleans, New York, and Huron, S. D., and its variation for the top 20 per cent of the total hours of June to September, inclusive. The curves for New York and Huron have about the same slope but at different levels while the New Orleans curve tends to level off quite rapidly resulting in a relatively high wet-bulb temperature extending over a long period of time.

Applying the wet-bulb temperature shown in Fig. 4 to the ventilation load, a series of curves result as shown in Fig. 5. Again New Orleans is highest with New York and Huron, S. D., following, the same as indicated in Fig. 4, with, however, one important difference; the order of magnitude of the variations of temperature with the variation in load.

The wet-bulb temperature is an index of the total heat in a water vapor-air mixture. The total heat increases per degree with an increase in wet-bulb and decreases per

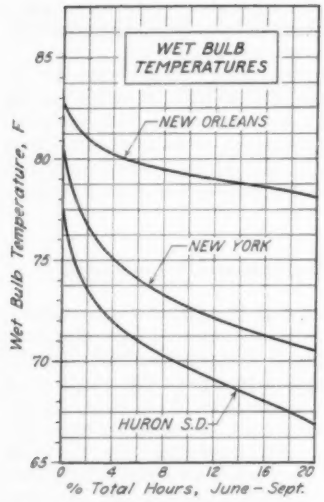

Fig. 4 Wet-bulb temperature variations for to p20 per cent of total hours, June through September

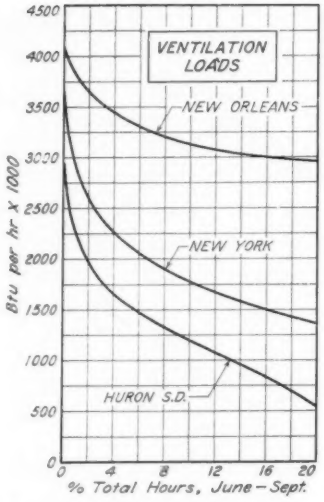

Fig. 5 Ventilation-load differences for the three cities for top 20 per cent of total hours considered

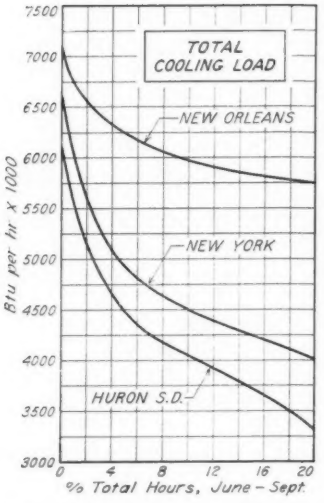

Fig. 6 Variation in total load as affected by variations in dry-bulb and wet-bulb temperatures

Table 1 Air-Conditioning Load, Btu Per Hr

	New York	New Orleans	Huron, S. D.
Transmission	240000	320000	350000
Solar radiation	370000	340000	400000
People	700000	700000	700000
Lights	1500000	1500000	1500000
Ventilation	2170000	3380000	1560000
Total	4980000	6240000	4500000
Design DB-WB	87–74.4	90.6–80	92.5–71.3

degree with a decrease in wet-bulb temperature. Comparing the percentage reduction in wet-bulb temperature from 0 to 20 per cent of the top total hours with the percentage reduction in load for the same period shows:

	Per cent	
New Orleans	24.5	reduction in temperature
	28.0	reduction in load
New York	56	reduction in temperature
	62	reduction in load
Huron, S. D.	70	reduction in temperature
	82	reduction in load

This illustrates that the reduction in load increases at a greater rate than the reduction in temperature.

Total Air-Conditioning Load

The total load given in Table 1 represents that of an office building and has been calculated for the outside dry and wet-bulb design conditions indicated and corresponds to conditions which are exceeded only 5 per cent of the total hours for June to September, inclusive. These conditions are used only to illustrate the comparative values of the load components and are not necessarily the optimum design criteria. The optimum design criteria must be left to the judgment of the engineer.

The figures indicate that the transmission load for New York and New Orleans is only 5 per cent and Huron 8 per cent of the total load; therefore any increase in dry-bulb temperature up to 0 per cent of total time, as shown in Fig. 1, would result in only a small change in the total load.

The solar radiation is $7^1/_2$, $5^1/_2$, and 9 per cent, respectively, of the total loads for New York, New Orleans, and Huron. As the solar-radiation design values closely approach the maximum values and as the duration of maximum intensity is so short, there is little danger of any increase in total load from this source.

The loads from people and lights show 44, 35, and 49 per cent of the total load, respectively, for New York, New Orleans, and Huron.

The ventilation load shows 43, 54, and 35 per cent of the total load, respectively, for New York, New Orleans, and Huron, and because of its magnitude a small increase in wet-bulb temperature can overload the system seriously and result in discomfort to the occupants.

Fig. 6 shows the variation in total load as it would be affected by the variation in dry-bulb and wet-bulb temperature as shown in Figs. 1 and 4. If 5 per cent of the total hours are taken as a design value which was used to calculate the total loads shown in Table 1, then the per cent increase to the maximum load to be expected approaching 0 per cent time would be 35 per cent for Huron, 31 per cent for New York, and only 12 per cent for New Orleans. This means that the design wet-bulb temperature cannot be set arbitrarily at the same percentage of total hours for all localities if the engineer wishes to limit the magnitude of overload and degree of discomfort in a given application.

If, for example, the 12 per cent overload for New Orleans was used as a design basis for New York and Huron, then the per cent of total hours would be $2^1/_2$ per cent for both New York and Huron instead of the 5 per cent used for New Orleans. This would mean a design dry bulb and wet bulb of 91–76.2 for New York and 97.5–73 for Huron instead of the 87–74.4 and 92.5–71.3 used in Table 1 corresponding to the 5 per cent values.

In view of the wide variation in weather design factors, it is important that the engineer consider carefully the effect of these variations in the design of any air-conditioning system.

An Engineering Society's Responsibility in the Field of Management

By Louis E. Newman[1]

Chairman, Executive Committee,
ASME Management Division

At the invitation of the American Institute of Electrical Engineers (AIEE), this report was prepared on the Management Division of The American Society of Mechanical Engineers. The reasons for extending this invitation to ASME were: (1) The problems of engineering management are common to all engineering societies, and the AIEE Management Committee believed that it might receive useful ideas for its future guidance by reviewing the experience of the Management Division of another Society. (2) The ASME's interest in and contributions to scientific management antedate those of any other society.[2]

The American Society of Mechanical Engineers was founded in 1880. Henry Robinson Towne, President of the Society in 1889, presented a paper in 1886, entitled, "The Engineer as an Economist." This paper has been called the birth of scientific management. It was followed by Frederick Winslow Taylor's pioneering papers presented before the Society in 1895, 1903, 1906, and 1911. Taylor was president of the Society in 1906.

Taylor's 1911 paper "Principles of Scientific Management" caused so much interest in ASME that a Subcommittee on Administration was appointed to make a thorough investigation of scientific management. At the Annual Meeting in 1912, this committee made its report on "The Present State of the Art of Industrial Management." Interest continued to increase in the Society and a Management Section[3] was formed in 1920, with Wallace Clark as chairman of the Organizing Committee.

In these early days of scientific management other societies were being formed. The Society for Advancement of Management (SAM) was formed in 1936, by a merger of the Taylor Society (1912) with the Society of Industrial Engineers (1917). The American Management Association (AMA) has been so named since 1922, although its origins stem from the National Personnel Association and earlier from the National Association of Corporation Schools (1913). In this country and abroad, particularly during the period from 1925 to 1930, other societies and trade associations were being formed with most of their attention devoted to discussions of management.

Functions of Management Division[4]

The objects and scope of activities of the Management Division of The American Society of Mechanical Engineers stem from the stated objects of the Society and of a Professional Division, and the objects of these groups are as follows:

I. The objects of ASME are officially recorded as follows:

(a) In the ASME Charter:

"The particular business and objects of such Society are, to promote the arts and sciences, connected with engineering and mechanical construction for scientific purposes, and to that end to meet and associate together to read and discuss professional papers, and to circulate by means of publication among its members the information thus obtained, and for the purpose of maintaining a library."

(b) In the ASME Constitution:

"To promote the art and science of mechanical engineering and the allied arts and sciences; to encourage original research; to foster engineering education; to advance the standards of engineering; to promote the intercourse of engineers among themselves and with allied technologists; and severally and in co-operation with other engineering and technical societies to broaden the usefulness of the engineering profession."

II. The object of each Professional Division, as given in the ASME By-Laws—Article B10, Par. 1, is as follows:

"The object of each Professional Division shall be to provide, through an organization of members of any or all grades particularly interested in a branch of engineering included in the scope of the Society's activities, means for promoting the arts and sciences of that branch."

III. The scope of the activities of the Management Division shall encompass that branch of engineering whose interest is management, defined as follows:

Management is the art and science of planning, organizing, measuring, and directing human effort, applied to control and utilize the forces and the materials of nature to achieve objects.

[1] Manager, Education and Training Services, General Electric Company, New York, N. Y. Mem. ASME.

[2] The historical background of management associations is well documented by Harry Arthur Hopf, President, National Office Management Association, in his paper, "The Management Movement at the Cross-Roads," presented at a meeting of the presidents of management societies, December 20, 1932, in New York.

[3] The first Executive Committee consisted of L. P. Alford, Chairman; L. W. Wallace, Vice-Chairman; F. B. Gilbreth, C. E. Knoeppel, Sanford E. Thompson, and W. H. Gruel, Secretary.

Paper presented at the Annual Meeting of the American Institute of Electrical Engineers, New York, N. Y., February 2, 1955.

[4] This is copied in full from a statement on the functions of the ASME Management Division adopted in 1954.

IV. The objects of the Management Division are:

(a) To improve management by the application to it of engineering science and the engineering point of view.

(b) To serve the management interests of:

1 ASME members who are interested in learning management techniques and improving their management abilities.

2 Managers of engineering functions.

3 Engineers in general management.

4 Engineers of management, who are concerned with the development and application of management skills and knowledge.

V. To accomplish its objects, the Division may undertake action to:

(*a*) Determine the need for original and applied research in the fields of management, organize and sponsor committees for research programs, and encourage and guide their work.

(*b*) Spread knowledge in the field of management to engineers and managers by encouraging the preparation, presentation, and publication of papers.

(*c*) Plan timely programs so that meetings will be interesting, informative, and inspiring, and design programs for the cross-fertilization of ideas in engineering and management.

(*d*) Develop and stimulate new means of advancing engineering knowledge and the application of engineering methods in the fields of management.

(*e*) Bring to the associate members of ASME a full and professional concept of management and aid those who aspire to management work in developing their managerial abilities.

(*f*) Stimulate and encourage leadership in the fields of management where ASME, as an engineering society, is better able to serve than other organizations.

(*g*) Attract men of character, vision, and ability to ASME membership by the high quality of purposes and accomplishments of the Division's activities, and by invitations to participate in the Division's work.

(*h*) Maintain close liaison and co-operate with the Sections, Divisions, and Committees of ASME in furthering interest in the fields of management.

(*i*) Co-operate with other societies in promoting the objects of the Division and the Society.

(*j*) Assist in the development and application of better management practices in small and large industries, services, and economic units.

(*k*) Stimulate and increase international-management activities by developing an exchange of management procedures, skills, and important management literature with engineering-management groups abroad.

(*l*) Further the engineering point of view and the application of engineering principles to management-employee relationships, human relations, and public relations.

(*m*) Co-operate with colleges and universities in the extension and improvement of sound curricula in the teaching of management principles, practices, and techniques.

(*n*) Encourage management in industry to develop a better understanding of its responsibilities to the owners, employees, customers, and general public, and how it can most usefully serve the balanced best interests of these groups.

Organization of the Management Division

The Management Division is one of 22 divisions[5] of ASME. Management of the Division's affairs is vested in an Executive Committee of five members, each of whom is appointed for a term of five years, with the term of one member expiring each year. The Executive Committee and such officers as the Division may require are selected from members of ASME. Other committees, committee chairmen, advisers, and associates of the Division are appointed by the Executive Committee, as required to serve the needs of the Division, for a term not exceeding one year.

The Executive Committee[6] elects its own officers and appoints its own secretary, but receives a considerable amount of help in carrying on its work from the ASME headquarters staff.

The Executive Committee is assisted in its work by the following subcommittees, each of which is appointed annually:

The General Management Committee is an advisory committee without a chairman, and with no regularly assigned duties or any regularly scheduled meetings. Its members are former chairmen of the Executive Committee or other members of the Society whose advice is highly valued by the Executive Committee. Members of the General Management Committee are invited to all regular Executive Committee meetings and frequently attend these meetings.

The Distribution Committee represents the Executive Committee in the field of Distribution. Distribution, in so far as this committee is concerned, is considered in its largest sense which includes, among other functions: advertising, selling, credit financing, transporting, storing, installing, and servicing.

The Honors and Awards Committee recommends to the Executive Committee candidates for those honors and awards falling within the scope of the Management Division.[7] After the Executive Committee approves the selections, the Honors and Awards Committee prepares the supporting material to justify the candidate's receiving consideration for the award.

The Human Engineering Committee is a newly appointed committee which will represent the Division in the field of ergonomics, or man-machine relationships. It is thought that the work of this committee will be of increasing importance.

The Work Standardization Committee has been estab-

[5] ASME has 22 divisions consisting of Applied Mechanics, Aviation, Fuels, Gas Turbine Power, Heat Transfer, Hydraulic, Industrial Instruments and Regulators, Machine Design, Management, Materials Handling, Metals Engineering, Oil and Gas Power, Petroleum, Power, Process Industries, Production Engineering, Railroad, Rubber and Plastics, Safety, Textile Engineering, Wood Industries, and Nuclear Engineering.

[6] The present membership of the Executive Committee is as follows: Louis E. Newman (1955), Chairman; Henry N. Muller, Jr. (1956), Vice-Chairman; Edward R. Murphy, Secretary; Frederick W. Hornbruch, Jr. (1957); Robert G. Hess (1958); and Charles A. Jurgensen (1959).

[7] The Management Division proposes members for promotion to the grade of Fellow in the Society and nominates candidates for the following awards: ASME Honorary Membership, ASME Medal, George Westinghouse Medal, Worcester Reed Warner Medal, Melville Medal.

lishing definitions for terms used in the field of industrial engineering. It has completed and received approval for some 500 definitions which have been published[8] this year. This is an important contribution to improving communication and understanding.

The Papers Committee serves the important function of receiving and reviewing papers for the Management Division. These papers may be solicited, or unsolicited, and may have been prepared by a member or nonmember of ASME. Any paper approved for presentation at a National Meeting must have the approval of at least one member of the Executive Committee.

The Program Committee assists in setting up programs for National Meetings.

The Publicity Committee handles publicity for National Meetings.

The Sections Contact Committee advises the Local Sections on activities in the field of engineering management.

In addition to these subcommittees of the Executive Committee, the Executive Committee has direct representation on the committee sponsoring the Time Study and Methods Conference, a joint venture of ASME and SAM, and is consulted in the appointment of Society representatives on the Council for International Progress in Management (CIPM), Wallace Clark International Award Board, and the Gantt Medal Board.

The reason so many committees exist within the Management Division is to provide a means for dividing the work to be done between busy engineers with primary responsibilities other than their ASME work.

Meetings of the Management Division

The Executive Committee of the Management Division decides the time, place, and frequency of its committee meetings. It is currently meeting on or about the second Tuesday of each month, at ASME headquarters in New York, from 7:30 to 10:00 p.m. Because of the frequency of these meetings, and the need for having each member present, it has become usual to select as members of the Executive Committee[9] only those who live within reasonable air-travel distance of New York. There is no reason other than convenience to the Committee members that dictates holding the meetings in New York. There are many important qualifications behind the selection of an Executive Committee member, but these can be effective only if the member is present at meetings.

The Management Division's activities are designed to meet the needs of the individual members of ASME. Out of the Society's approximately 40,000 members, about 10,000 have registered in the Management Division, giving it the largest enrollment of any ASME division. These include engineers newly graduated from college, engineers not actively managing but certainly interested in the problems of managers, managers of engineering work, and general managers. To meet this diversity of membership needs, the following major activities are sponsored by the Management Division:

Section Meetings. In each of ASME's 83 Sections, where there is sufficient interest in Management, papers are prepared and presented to the local membership.

National Meetings of the Society. The Society normally holds Annual, Semi-Annual, Spring, and Fall National Meetings at each of which one or more sessions are devoted to the presentation of papers on management. For the most part these papers are solicited by the Executive Committee of the Management Division on the basis of a selected speaker with a specific subject. Sessions can thus be planned with a single theme tying several papers together.

Management Division Conference. Each year a two-day meeting is held (in March) devoted entirely to subjects of interest to the Management Division. The cities in which these meetings have been or will be held are:

1st Annual Management Division Conference—Detroit	—1953
2nd Annual Management Division Conference—Philadelphia	—1954
3rd Annual Management Division Conference—Cleveland	—1955
4th Annual Management Division Conference—St. Louis	—1956
5th Annual Management Division Conference—Pittsburgh	—1957
6th Annual Management Division Conference—Boston	—1958

These conferences are held at the invitation of local sections with representatives of those sections and one member of the Executive Committee being responsible for the planning of the program, inviting the speakers, and making arrangements for the meeting. These meetings are entirely self-supporting financially from registration fees set at a level high enough to pay for all expenses of the conference except printing the program.

The Cleveland meeting in 1955 had as its theme "More Engineering at Less Cost." Over three hundred were in attendance. The majority of these came from the region surrounding Cleveland and most of these were ASME members, but there was a good representation from other societies, and most of the States and Canada were represented at the meeting. These conferences are held because it has been found that the mangement sessions at the four National Meetings of ASME are not enough to take care of the Division's needs in particular areas of management.

Management Executives' Conference. Each fall for the past eight years the Executive Committee has sponsored on an invitation basis a top-executive conference to provide a forum for policy-level discussions of important management problems. Attendance has been limited to less than 100 conferees of whom about one third have been presidents of their respective companies. In order not to draw on funds contributed by others, this conference is supported by its own separate registration fee. The conference has been a three-day meeting held at a secluded location, Skytop, Pa., so that those in attendance had facilities for close, informal contacts, without big-city diversions, outside of the actual sessions. This has been a popular and valuable feature of these conferences.

Time Study and Methods Conference. The Time Study and Methods Conference is jointly sponsored by the Society for the Advancement of Management (SAM) and ASME. The greater share of the responsibility for this conference has been carried by SAM, but the present plan

[8] ASME Standard No. 106, "Industrial Engineering Terminology," published in 1955 by The American Society of Mechanical Engineers, 29 West 39th St., New York 18, N. Y.

[9] Present members of the Executive Committee are located in New York, Pittsburgh, Philadelphia, Cleveland, and Trenton.

is to continue these two-day conferences as an annual joint venture with chairmanship of the conference alternating between the two societies. This year's conference, the tenth, was held in New York City on April 28 and 29. Attendance exceeded fourteen hundred.

Responsibility for Meetings

Responsibility for each National Meeting sponsored by the Management Division is assigned to one member of the Executive Committee. This responsibility is rotated so that by the time an Executive Committee member completes his term of five years, he will have had responsibility for each meeting. In this way responsibility is shared so that it is not burdensome in any year. Table 1 shows the present plan for assignment of

Table 1 Assignment of Responsibility for Meetings

	Meeting	Executive Committee responsibility assigned to
1	Time Study and Methods Conference	Chairman
2	Management Executive Conference	Vice-Chairman
3	Management Division Conference	3rd Year Member
4	Semi-Annual General Meeting	3rd Year Member
5	Annual General Meeting	2nd Year Member
6	Spring General Meeting	1st Year Member
7	Fall General Meeting	1st Year Member

responsibility. This has been extended for five years so that each member of the Executive Committee can see the responsibility ahead of him for his entire term of membership.

Research

The Executive Committee can undertake research in the field of management. A notable example of this was a research study that culminated in 1950 with a book by Dr. Edward H. Hempel titled "Small-Plant Management."[10] Royalties from the sale of this book go to the custodian fund of the Management Division.

A second example is a project now in process that is expected to result in a book of case problems in engineering administration. This project is under the leadership of Dr. J. E. Walters, Rutgers University. It is sponsored by ASME's Research Committee with the assistance of the Management Division.

Ten Years' Progress Report

Special mention should be made of the "Ten Years Progress Report in Management" issued by the Management Division each decade since Dr. L. P. Alford made his report of 1912, on "The Present State of the Art of Industrial Management." It is probable that these progress reports, in the aggregate, are the best single historical record of the Management Movement over the first half of the twentieth century. These reports constitute a significant and valuable contribution by ASME to the study of management.

It is of interest that Dr. Lillian M. Gilbreth, in concluding the foreword to the 1952 Report,[11] said:

"Our chief problem seems to be to enable more people to have work that will produce not only necessary goods, but satisfaction to them and to everyone. We look forward to a future of effort, and of service."

Need for a Management Division

There are two areas where a Management Division within an Engineering Society serves a need not easily filled by an outside organization. One of these serves the engineer who becomes professionally competent without himself becoming a manager. The relationships between such an engineer and his manager are of vital importance to both. They call for a sincere interest in and understanding of the manager's work and responsibilities by the engineer as much as for clear perception by the manager of the engineer's objectives, work, interests, and participation. Such an engineer makes technical decisions which have important impact on the manager's work and makes progress on which the progress of his whole component and his manager depends closely. The need for work and teamwork, for close and voluntary integration of effort and thinking, and for pursuit of common purposes with good two-way communication is a deep responsibility for both. Many papers presented by the Management Division cover areas of interest for such an engineer.

The second area of interest served by a Management Division is that of the engineer who has shifted, or is considering shifting, from the work of a professional engineer to the work of a professional manager, which is increasingly recognized as both a distinct and a professional kind of work as such. This man may be interested first in the work of managing an engineering operation—or part of such a functional component—or in managing multifunctional activities or even a business as a whole (as general manager). For him, too, the activities and papers of a Management Division in his engineering society can be valuable in his new, as well as his former, strictly technical, capacity.

The Future

Management, whether in the sense of management of engineering, or management of broader areas by men starting as engineers, is a matter of common interest to all engineering societies. With the growth in importance of an understanding of scientific management by engineers, there is the likelihood that each engineering society will increasingly be hearing the same speakers. Certainly the leaders like Dr. Gilbreth, Harold F. Smiddy, H. B. Maynard, L. A. Appley, Phil Carrol, J. K. Louden, and others who have been active in ASME's Management Division have information valuable to engineers other than mechanical engineers.

Any possible danger of carrying such separate approaches to the possibly undesirable extreme of fragmenting our available talent in engineering management may be avoided by more joint efforts of the engineering societies. Perhaps we should form a joint committee of representatives from several of the major engineering societies to study the feasibility of a joint annual Engineering Management Conference. The Executive Committee of the Management Division of ASME would welcome others joining with us to promote broader understanding and further development of the field of scientific management by more engineers from a widening group of engineering societies.

[10] McGraw-Hill Book Co., Inc., New York, N. Y., 1950, 548 pages.
[11] 1942–1952 Edition, published by The American Society of Mechanical Engineers. Price $1.50.

Fig. 1 The Flatiron Power and Pumping Plant is the terminal plant of the transmountain water-diversion system of the Colorado-Big Thompson Project

Flatiron Power and Pumping Plant . . .

. . *including design features of 48,000-hp Francis-type turbines at Colorado-Big Thompson Project*

By John Parmakian[1]

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THE Flatiron Power and Pumping Plant, Fig. 1, is the largest and also the terminal plant which utilizes the power drop in the transmountain water-diversion system of the Colorado-Big Thompson Project. This completed project is a recent Bureau of Reclamation development which diverts water from the Colorado River on the western slope of the Continental Divide through the 13-mile-long Adams Tunnel to the eastern slope. It provides irrigation, hydroelectric power, and other benefits for a large area northeast of Denver, Colo. The profile diagram of the power-drop and irrigation features of the diverted water on the eastern slope, and a profile of that portion which affects the Flatiron Power Plant are shown in Figs. 2 and 3, respectively.

The design of this system is based on a water supply of 340,000 acre-feet of which 310,000 acre-feet are diverted from the western slope and 30,000 acre-feet are obtained from the Big Thompson River. Water for the Flatiron Power Plant is supplied via the Flatiron penstocks and the Bald Mountain Pressure Tunnel from the Rattlesnake Reservoir. This reservoir receives its discharge from the Pole Hill Power Plant. The afterbay of the Flatiron Power Plant supplies water to the Horsetooth Feeder Canal. Carter Lake, which furnishes water to the St. Vrain Supply Canal, is supplied from the Flatiron afterbay by the reversible pump turbine in the Flatiron Pumping Plant. Provisions also are made for the generation of power at the pump turbine when Carter Lake water is released back through the plant to the Flatiron afterbay.

General Features

The Flatiron Power and Pumping Plant structure shown in Fig. 1 is a semi-indoor installation. It consists of a reinforced-concrete structure which rests on siltstone, claystone, and sandstone. The roof is located high above the bed of the creek and is above any flash flood that is expected to occur in this locality. The main powerhouse crane of 100-ton capacity is mounted on the roof deck.

[1] Head, Technical Engineering Analysis Section.

Contributed by the Hydraulics Division and presented at the Diamond Jubilee Spring Meeting, Baltimore, Md., April 18–22, 1955, of THE AMERICAN SOCIETY OF MECHANICAL ENGINEERS. Paper No. 55—S-30.

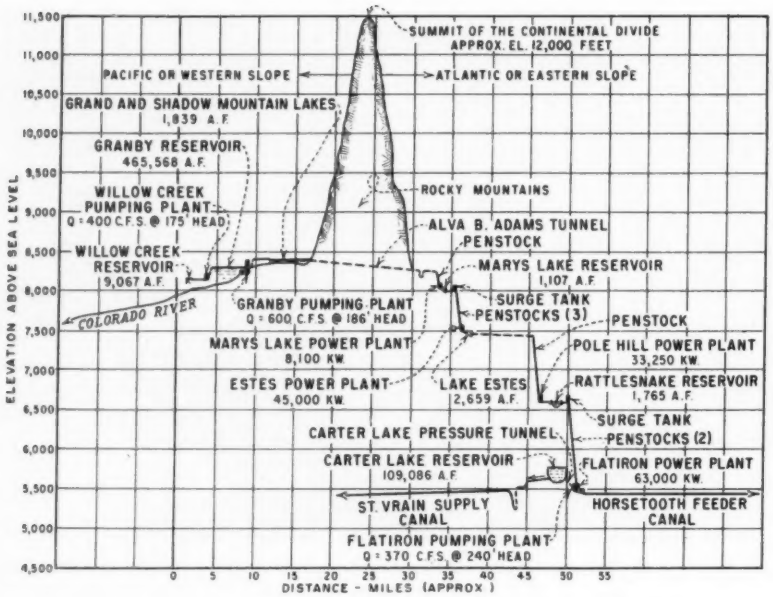


Fig. 2 Profile diagram of the Colorado-Big Thompson water-diversion project

The combination plant contains two 48,000-hp Francis-type turbines and one reversible pump turbine motor generator unit. The two main generating units have a combined hydraulic capacity of approximately 960 cfs and operate under a maximum static head of 1118 ft. These units are designed to provide peak-load generation for the interconnected power system. The reversible pump-turbine unit has a rated pumping capacity of 370 cfs at a head of 240 ft and is designed to supply Carter Lake during off-peak hours. The unit also may be used for peak-load generation at any time.

Surge Tank

The Bald Mountain Pressure Tunnel conveys water from the Rattlesnake Reservoir to the Flatiron penstocks. This 6700-ft-long tunnel is served by an inlet channel and trashrack structure in the reservoir and is provided with a 50-ft-diam surge tank near the outlet portal of the tunnel. This simple, restricted-orifice-type underground surge tank is designed to minimize the pressure surges induced by the sudden rejection of the flow at the turbines and to supplement the tunnel supply when the plant load is increased suddenly. It provides for contemplated fluctuations of 70 ft between maximum downsurge and upsurge in the surge tank.

Penstocks

Two parallel, variable-diameter, 84-in., 78-in., and 72-in. welded and riveted, plate-steel penstocks are provided as waterways to carry water from the outlet of the Bald Mountain Pressure Tunnel to the main generating units in the Flatiron Power Plant. The penstocks are about 5800 ft in length and have a maximum shell thickness of $1^5/_{16}$ in. at the lower end. For the upstream portion of each penstock comprising about 2700 ft, an ASTM Designation A285 Grade C steel was used. For the remaining lower portion of each penstock a higher-strength ASTM Designation A212 Grade B steel was used. All penstock sections fabricated from the A212 steel and from the A285 steel over 1 in. in thickness were thermally stress-relieved after welding. Each individual erection section was then subjected to a hydrostatic pressure test in a specially designed pressure-testing machine where a test pressure of $1^1/_2$ times the design pressure was applied.

The field girth joints which were made from A285 steel were butt-welded and those made from A212 steel were butt-riveted, except the downstream end sections which were Dresser-coupled. For the most part the penstocks were installed above the ground with supports consisting of double-ring girders welded to the pipe. The penstocks were fabricated and installed by the Southwest Welding and Manufacturing Company.

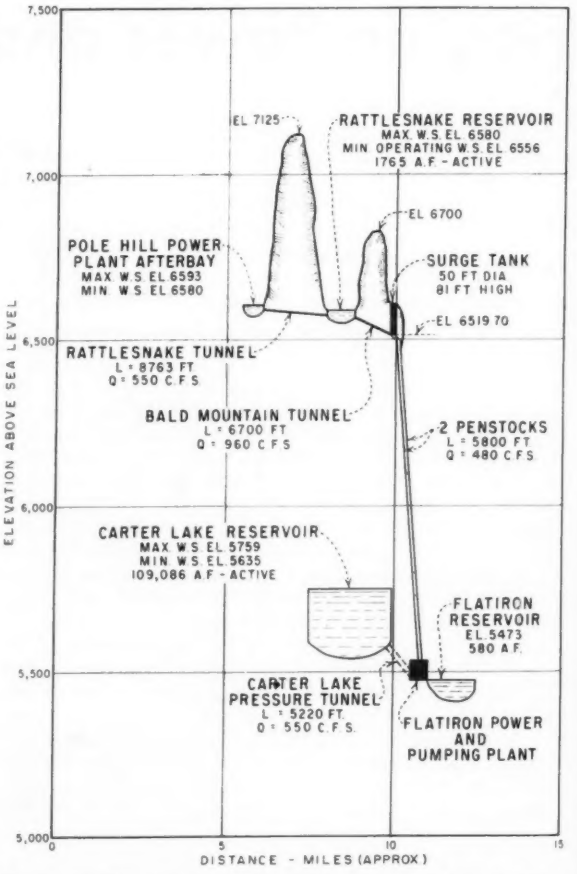


Fig. 3 Profile of section of the project which affects the Flatiron Power Plant

Turbines

The main turbine installation for the plant consists of two vertical-shaft, Francis-reaction-type, 514-rpm, hydraulic turbines, each having a capacity of 48,000 hp at full gate opening when operating under an effective head of 1055 ft. The general arrangement through one of these units is shown in Fig. 4. Each turbine spiral case, pressure-regulator valve body, and other parts subject to penstock water pressure, are designed for 600 psi, which is the maximum pressure including water hammer that can be obtained with the pressure-regulator functioning. They were shop-tested at 900 psi, field-tested at 600 psi, and embedded in concrete while under an internal pressure of 450 psi.

Each turbine is designed and constructed so that all removable parts may be removed from above by means of the main powerhouse crane, and so that all turbine parts can pass through the circular pit below the generator and through the generator stator.

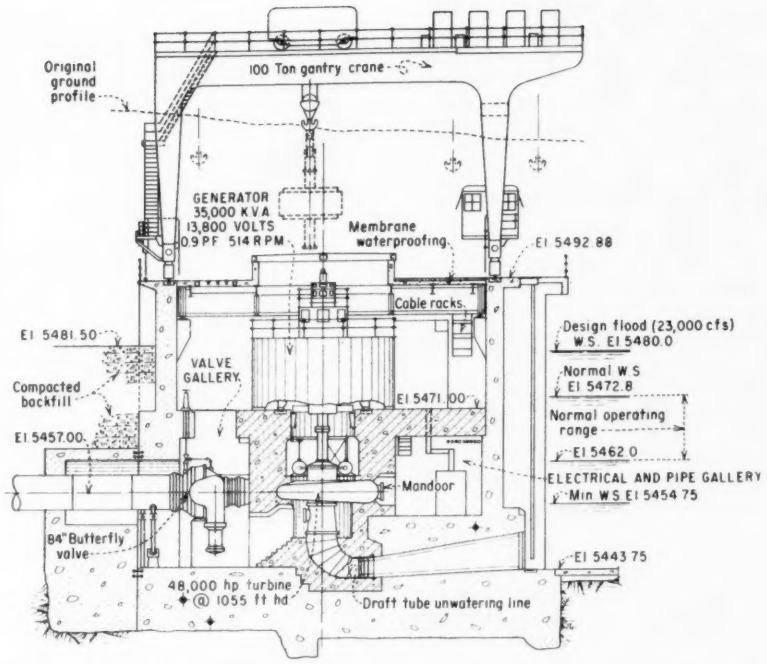


Fig. 4 General arrangement of one of the two 48,000-hp Francis reaction-type main hydraulic turbines

A critical shortage of nickel existed during the period of construction of the Flatiron turbines and for this reason aluminum bronze was substituted in most of the parts where stainless steel was originally called for in the specifications. This substitution included the runners which are cast of "Ampco" aluminum bronze. However, a spare interchangeable carbon-steel runner also was provided. The turbines and pressure-regulator valves were designed and furnished by the Pelton Water Wheel Company.

Pressure Regulators and Governors

A pressure regulator of the internal-needle type is installed at each turbine to reduce the pressure rise in the penstock caused by the rapid closure of the turbine wicket gates and to provide a water by-pass during periods of shutdown. The water passage for the pressure regulator or relief valve for each unit is directly connected to the turbine spiral case and is designed to operate either as a synchronous by-pass or as a watersaving relief valve having a capacity equal to 100 per cent of the flow capacity of the connected turbine. It is mechanically connected to the turbine wicket-gate mechanism and will stall the servomotor if the pressure-regulator valve sticks or fails to open, thus insuring a limitation on the water hammer during rapid load rejections.

The pressure regulator normally is set to operate as a watersaving relief valve which opens in step with the wicket-gate closure at rapid load rejection and then slowly recloses under the control of a dashpot. It does not open when the wicket gates slowly close during normal load changes. Each pressure regulator also can be operated as a continuous by-pass when the turbine wicket gates are closed.

The governors for regulating the speed of the turbines are of the oil-pressure, cabinet-actuator type, with electrically driven speed-responsive elements. The governor rating corresponding to the capacity of the turbine servomotors is 70,000 ft-lb. The actuator main relay valves are adjusted to limit the rate of movement of the turbine gates between 5 and 15 sec for a full gate-opening or gate-closing stroke. The governors were designed and furnished by the Woodward Governor Company.

Generators and Pump Turbine

The two main generators are 3-phase, 60-cycle, alternating-current machines with an output of 35,000 kva each at the rated voltage of 13,800 volts and at 90 per cent power factor. Each generator has a self-aligning vertical equalizing Kinsbury-type thrust bearing and an upper-guide bearing located above the rotor, and a lower-guide bearing below the rotor. All parts of the generators and exciters are designed and constructed to withstand safely the stresses resulting from a runaway speed of 950 rpm. The generators were manufactured and installed by the Westinghouse Electric Corporation.

The pump turbine at the Flatiron Power and Pumping Plant is of particular interest since it is one of the first large units of its type to be placed in service in the United States. The general arrangement through this unit is shown in Fig. 5. The pump rating is 370 cfs at 240 ft total head. As a turbine-driven generator the unit is rated at 8500 kva. The combination unit is basically a pump with only 6 impeller vanes but it has fixed stay vanes like a turbine. It has no wicket gates or governor and therefore always operates as a turbine at "full gate." The butterfly valve adjacent to the unit is held in the wide open position when the unit is

pumping or generating. Because of the dual type of operation, trashracks are provided at both head water and tail water. A 42-in-diam submerged tube valve is installed in the conduit system to by-pass the pump-turbine unit when the irrigation flow requirements exceed the water capacity of the unit as a turbine.

At this installation the head on the unit varies from 290 to 140 ft for the turbine and 170 to 300 ft for the pump. Model tests by the pump-turbine manufacturer for the particular impeller selected indicated that with these head ranges higher efficiencies were obtained by running the turbine at a lower speed than the pump. The adapted speeds were 300 rpm pumping and 257 rpm turbining.

The pump-turbine spiral case and other parts subject to penstock pressure are designed for 200 psi, which is the maximum pressure that can be obtained with the discharge valve closed and a runaway speed in the pumping direction of 340 rpm. The pump-turbine was designed and built by the Allis-Chalmers Manufacturing Company.

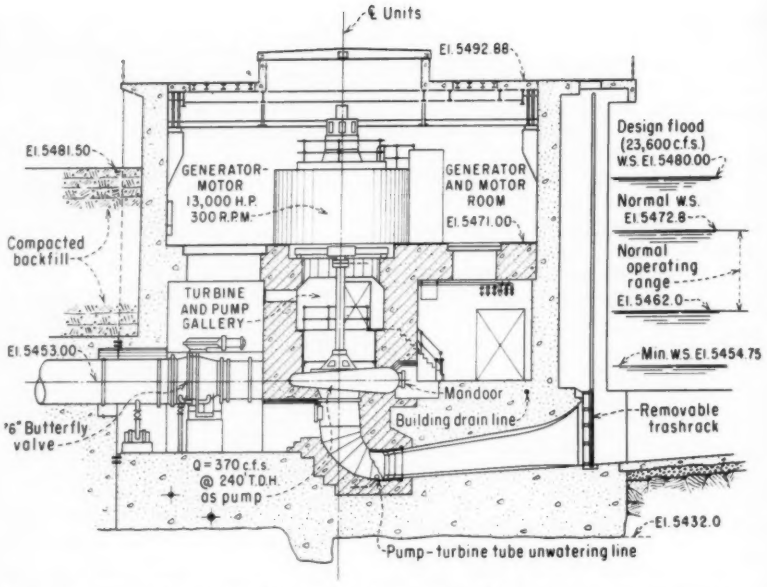


Fig. 5 Cross section through combination pump-turbine motor generator unit

Motor Generator

The motor generator at the Flatiron Power and Pumping Plant is designed for use either as a motor to drive the pump or as a turbine-driven generator. The unit is of the vertical-shaft, alternating-current, 3-phase, 60-cycle, 13,800-volt, synchronous type and is directly connected to the pump turbine. The motor generator has a thrust bearing and an upper-guide bearing located above the rotor, and a lower-guide bearing located below the rotor. The entire rotor assembly of the motor generator, shaft, and pump-turbine runner is supported by a Kingsbury-type thrust bearing. This bearing also is arranged for pressure lubrication so that it can support the weight of the rotor assembly on a film of oil when starting in either direction to give a low starting torque. The unit is designed for operation at speeds of 300 and 257 rpm either as a pump-motor or as a turbine-driven generator. It is capable of operating as a 13,000-hp synchronous motor at a speed of 300 rpm, a 10,700-hp motor at a speed of 257 rpm, as a generator rated 8500 kw at a speed of 257 rpm, and as a 10,000-kw generator at a speed of 300 rpm. These ratings are based on operation at 100 per cent power factor. The unit also can be operated as a synchronous condenser.

The arrangement for obtaining the 2-speed synchronous machine is by the use of two electrically independent windings on the stator, either one of which can be selected for use by selector switches and by a rotor winding consisting of 24 poles. For motor operation at a speed of 300 rpm, the 24-pole stator windings are used with the 24-pole rotor windings. For generator operation at a speed of 257 rpm, the 28-pole stator windings are used and an equivalent of 28 poles on the 24-pole rotor windings are obtained by a special switching apparatus which also reverses the polarity of some of the poles.

The unit is designed and constructed so that it is capable of operation at both speeds and in both directions, but as normal operation will be either as a motor at a speed of 300 rpm or as a generator at a speed of 257 rpm, the switching arrangement is only designed to connect the windings for these two methods of operation. All parts of the motor generator unit are designed and constructed to withstand a runaway speed of 555 rpm in either direction. The motor generator was designed and built by the Allis-Chalmers Manufacturing Company.

Operation of Pump Turbine

To date the pump-turbine unit has been used most of the time as a pump because its primary function is to store water in the Carter Lake Reservoir. However, it also is used as a turbine whenever it is necessary to deliver water stored in Carter Lake to the Horsetooth Feeder Canal. As a pump the motor is started at full voltage with the impeller unwatered by means of compressed air to reduce the duration of the disturbances of the electrical system. After the unit is synchronized, the air is released and the discharge butterfly valve is opened. The unit is started as a turbine by opening the butterfly valve partially and using the by-pass valve as a vernier to obtain synchronous speed. The main circuit breaker is then closed and the butterfly valve opened fully to load the unit. To stop the unit the butterfly valve is closed before opening the circuit breaker.

Operation of the reversible pump-turbine at the Flatiron Plant has shown good performance both as a pump and as a turbine. Final results of field tests using the salt-velocity method indicate that all guaranteed efficiencies were exceeded. Present indications are that reversible units of this type will find increasing applications in modern hydroelectric systems.

Russia's Engineers . . .

. . . Sources of Soviet Power
. . . Threats to Soviet Power

By Demitri B. Shimkin

Social Science Analyst, U. S. Department of Commerce, Washington, D. C.

Two fundamental considerations dominate the selection, training, and use of physical scientists and engineers in the Soviet Union. The first consideration is the vital role of these specialists in building up Soviet military-economic strength, while the other is Communist fear of scientists and engineers as potential subversives.

Soviet Economic Policy

Since 1928, the basic objective of Soviet economic policy has been to maximize Russian war potential. To achieve this goal, the Soviet government has stressed the development of producers' goods industries, especially the manufacture of machinery. By the same token, it has sought to minimize the resources allotted to civilian consumption, transportation, maintenance, and other secondary sectors. And, in fact, the Soviet Union did increase its industrial output more than eightfold between 1928 and 1953. This rise, and the associated increase in the volume of construction, have accounted for 70 per cent of the growth of Soviet national income (at constant prices) over the past quarter-century. The Soviets also have been able to double industrial man-hour productivity since 1928. Their successes in intensifying the use of capital have been great. On the railroads, the tonnage of freight hauled per mile of first-line track quadrupled between 1928 and 1950 and is now about twice as high as in the United States. In electrical power, the Soviets have increased output per kilowatt of installed capacity from 2600 hours in 1928 to about 4900 in 1954, a record matching the American. In manufacturing generally, two-shift operation has been the postwar practice.

Production in Basic Commodities

In 1954 the volume of Soviet manufacturing and mining was about 35 per cent that of the United States. But for a number of commodities—coal, in bituminous equivalent lead, and steam turbines—it was 90 per cent as great. For machine tools, it was nearly 70 per cent; between 50 and 55 per cent for copper, zinc, and pig iron. However, the relative outputs of other important products were considerably smaller; tractors, 35 per cent of the U. S. level; electrical power, radio receivers, and cement, 27 per cent; petroleum, 13 per cent; and natural gas, less than 2 per cent. In addition, Soviet industrial man-hour productivity was only some 28 per cent of the American. Furthermore, the margins of capacity and of stock-piled supplies have remained inadequate for major military efforts. Even the Korean war strained the Soviet economy severely. The combination of war losses, long working hours, and low productivity has reduced the manpower available for military mobilization to two thirds the Soviet 1940 potential, and to less than that of the United States today.

The Objective—Military Strength

These then have been the factors underlying the tremendous continuing Soviet effort to enlarge Russia's scientific and engineering strength. The effort has embraced five elements; namely, incentive, selection, training, intelligence, and selective borrowing from the West, and research. Let me review these elements briefly, with major reliance upon the work of Nicholas DeWitt.

Incentive. During student and early professional years, the major incentive is prolonged deferment, or even exemption, from military service. Of course engineers, like all other Soviet professionals, must accept civilian assignment as directed. In later years the material rewards may become very large, with handsome salaries being supplemented by prizes and bonuses.

Selection. The base of selection is relatively narrow, with all higher education contingent upon fluency in Russian. Other political, economic, and cultural factors strongly favor the children of urban white-collar workers.

Training. Over the past quarter-century, 30 per cent of all Soviet graduations from institutions of higher learning, or twice the American ratio, have been in the physical sciences and engineering. As a result, the number of working graduates in these professions has increased, according to DeWitt's estimates, from 40,700 in 1929, to 541,000 in 1954.

The training given Soviet scientists and engineers is characterized by marked excellencies and by equally marked deficiencies. The duration of secondary and basic professional education, 8 years, and the content of the general science courses offered compare favorably with our own. Moreover, uniform standards are enforced by nationwide examinations at both secondary and higher levels. Soviet secondary education is primarily oriented toward preparation for a technical career.

Weaknesses. The most serious weakness of Soviet technical education is its subordination to production Ministries and even Administrations. This has led to premature and extremely narrow specialization, with overriding emphasis upon the minutiae of current practice, and with the avoidance of critical and experimental approaches. The absence of elective courses and the

Presented at 75th Anniversary, Panel II, during the Diamond Jubilee Spring Meeting, Baltimore, Md., April 18–22, 1955, of The American Society of Mechanical Engineers. Slightly condensed.

practical impossibility of changing from one curriculum to another reinforce the rigid compartmentation of Soviet education.

The teaching staffs in the physical sciences and engineering are heavily burdened, with a student load two thirds greater than in this country, and with about twice as many hours of teaching. Their task is made more difficult by acute deficiencies in teaching aids. The textbooks are either general, very conservative expositions, or detail-crammed technical manuals, or translations of Western works. Laboratory equipment and materials are very scarce.

Dependence on the West

As DeWitt has shrewdly observed, Soviet technical education is basically designed to mass-produce supervisors of manufacturing routine. This specialization is possible so long as necessary innovations can be borrowed systematically from the West. Before World War II, and especially before 1935, the Soviets had many of their new industrial plants designed and erected by Western firms, and selected Soviet engineers and workers were sent abroad for training, while Soviet scientists participated in international meetings and other exchanges.

During World War II, Lend Lease provided a massive transfusion of Western experience. Several thousand Soviet engineers were sent to the United States during this period to gain a comprehensive understanding of American industrial layout and practice. Advanced equipment was either imported or available from blueprints. The occupation of Germany provided further opportunities. All of this new information was rapidly assembled and organized. The direct fruit of this carefully used aid was a Soviet technological break-through in atomic energy and other weapons' development.

In all, one can scarcely overstate the dependence of the Soviet Union on Western, especially American, technology. The structure of Soviet industry—plant sizes, locations, and layouts—corresponds remarkably to the American.

Domestic Research Program

Dependence upon the West is a cheap and fairly sure way to achieve technological progress, but it incurs the disadvantages of a built-in time lag and of solutions inappropriate to peculiarly Soviet conditions. A domestic research program is essential to overcome these disadvantages.

Russian science has a strong tradition, with many outstanding figures, such as Lobachevsky in mathematics, Mendeleeff in chemistry, Fersman in geochemistry, and the Vavilov brothers in plant genetics. Government support, centralized organization, and planning have characterized Russian research for the past two centuries. Although Western coverage of Soviet published research is very poor, it is clear that at the present time only the United States surpasses the USSR in research volume. However, the successful applications of original Soviet research appear to be notably few.

Why? In part because of qualitative weaknesses in Soviet science itself, weaknesses in experiment design, instrumentation, and control which have led to unsure results. These weaknesses are vanishing. Other causes are the conservatism, compartmentation, and structural rigidity of Soviet industry, traits reinforced by Soviet technological selection and training systems. Even more important is Party dictation, which forces Soviet industry to produce at all costs, to improvise rather than to reach basic solutions.

Heavy Hand of Suspicion

Above all else the Soviet scientist and engineer is deeply suspected by the Party. His vital technical skills give him a power potentially challenging the Party's absolutism. To do his job, he must maintain contact with both the prerevolutionary past and with the West. And the logic of his work drives him into repeated conflict, open or hidden, with Party dogma and favoritism. Therefore the Party must take strong measures to maintain its control. It recruits its scientists from the most privileged group in the Soviet Union, the Russian urban elite. It presses them to join the Party, rather successfully for scientists and engineers as a whole, much less so for their teachers. Of the former, 38 per cent are Party members; of the latter, 17 per cent. The Party organizes elaborate networks of inspectors and informers. And, periodically, it imposes terror, forcing scientists to grovel to abase themselves before Party pronouncements, and at times, to die, in token of their subjugation to Marxist-Leninist-Stalinist infallibility.

Thus, in fighting potential subversion, the Party generates apathy and despair, if not actual subversion. In consequence, there is a constant flight from responsibility, from operations to administration or teaching. Despite the large number of engineers trained, the compulsions, and the great material incentives, shortages of skilled manpower in high-priority areas are chronic.

How Effective Is the System?

The selection, training, and use of physical scientists and engineers in the Soviet Union reveals paradoxical strengths and weaknesses. The application of science on a vast scale is essential to the realization of Soviet ambitions, yet the Communist Party dare not trust the scientist and the engineer. The Soviet Union fears the West, yet depends upon its technology. Given these circumstances, these conclusions may be advanced:

1 At present, the actual effectiveness of the Soviet Union in scientific innovation and application is far lower than might be indicated by the large numbers of its physical scientists and engineers, and by the immense Soviet effort in training and research.

2 In part, this gap lies in the failure to develop and apply increasingly good basic research. Thus Soviet science warrants far closer study by the West than Soviet technology indicates.

3 Beyond this, the Soviets are creating a potential which, given appropriate social changes, might generate a technological revolution.

4 At present, the Soviet utilization of Western technology is limited by Western controls on information flow and exports. Moves toward the modification of these controls should be guided by careful assessment of Soviet technological strengths and weaknesses

5 Finally, scientific and technical publications, including trade journals, constitute a channel of communication behind the Iron Curtain which the Soviet Union simply must keep open. This fact needs wider exploitation both as a means of insuring a reverse flow of data from the Soviet Union, and as a medium for the diffusion of a new hope for a world of peace.

Briefing the Record

Abstracts and Comments Based on Current Periodicals and Events

J. J. Jaklitsch, Jr., Associate Editor

Machine-Tool Automation

MILLING intricately contoured, low-tolerance workpieces on multi-axis machines completely controlled by magnetic tape—on which entire work cycles have been programmed solely from numerical data—was proved a present-day production reality by the Giddings & Lewis Machine Tool Company in a recent demonstration of their Numericord control system operating a skin-milling machine at the Company's Fond du Lac, Wis., plants.

Resulting from three years of Giddings & Lewis sponsored research at Massachusetts Institute of Technology and allied research at the General Electric Company, this is the first commercially available system to provide electronic preparation of machine-control magnetic tapes directly from numerical data. Of equal significance, this is the first application of completely automatic control to heavy-duty machines capable of handling large complicated workpieces.

The Numericord system presents a new, radically different, and greatly advanced solution to the problem of automating such machine tools.

With this system, machining cycles involving as many as five machine axes, and 22 auxiliary machine functions are completely planned and engineered by mathematical computation. Precalculated data, in normal decimal numerical form, are processed by the system's exclusive "electronic brain" computing director into continuous phase-modulated command signals, automatically recorded on magnetic tape. This "magnetic-memory" tape is electronically read in the machine control unit to operate minute-current-response, wide-range amplidyne servomechanisms which perform all feed and transverse functions automatically—repeating tirelessly and accurately the entire machining program for producing identical parts in any quantity, to tolerances limited only by the machine tool—ordinarily ranging ±0.001 to 0.002 in.

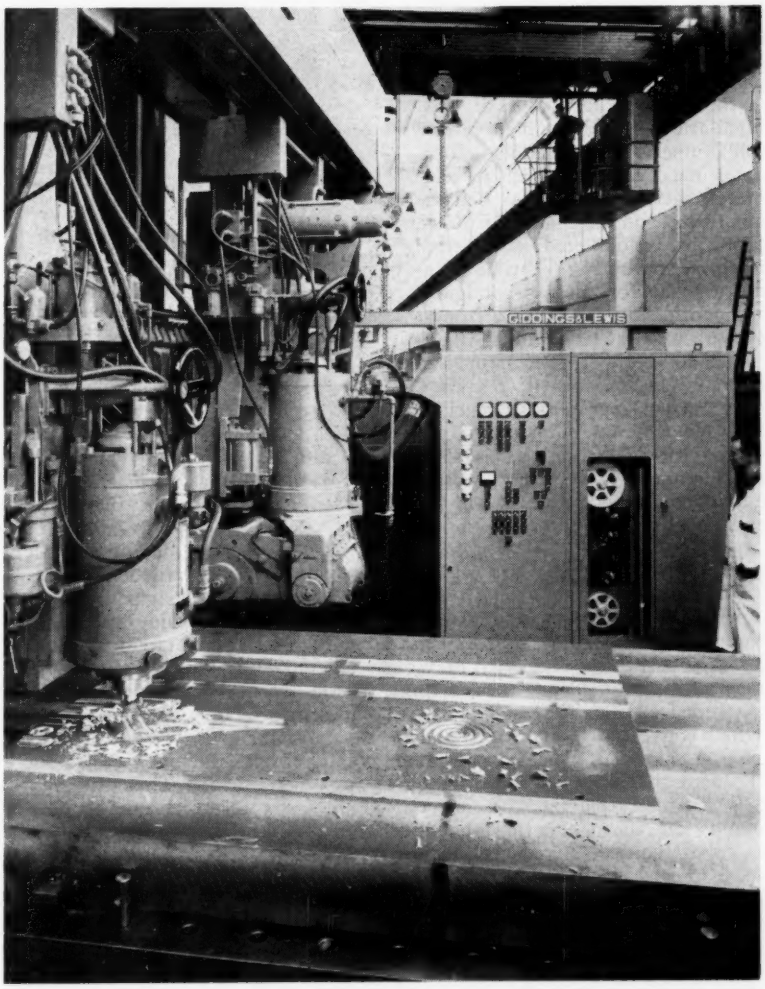


Fig. 1 Precision and machining versatility of the new Giddings & Lewis Numericord System of machine-tool automation are shown by the "plunge," "channel," and "pocket" milling cuts performed by this spar and skin-milling machine under complete control of a numerically prepared magnetic program tape. In addition to these cuts, the system's accuracy is demonstrated by the 4-in. radius Archimedean spiral seen in the right foreground of the aluminum workpiece. Behind this is shown the magnetic-tape playback unit which controls table and both heads in feed, transverse, rise, and fall. The system is capable of simultaneously controlling as many as five machine axes in three dimensions and up to 22 auxiliary machine functions. Even audio commands to the machine attendant can be included on the magnetic tape to alert him to tool-change and machine-inspection "stops" planned into the magnetic tape's machining program.

Applicable to Any Machine Tool

While applicable to virtually any machine tool, the new Numericord system was demonstrated at Giddings & Lewis in control of one of their aircraft-type spar and skin-milling machines performing all "plunge," "channel," "pocket," and contouring cuts necessary to mill complete jet-plane skin and wing panels from solid 75S-T aluminum plate. With it, such nonproductive operations as tool setting, gaging, template changing, and positioning are radically reduced or completely eliminated. Avoided, too, are time and material losses resulting from wasted operator motions, lack of skill, miscalculations, and human error. The Numericord system also eliminates inaccuracies inherent in template-tracer controls, as well as mounting and mechanical-linkage problems encountered in multiple template contouring. Estimates indicate that for aircraft-configuration work, similar to the horizontal stabilizer for the new North American F-100D Super Sabre, the Numericord system can effect savings of at least 50 per cent in machining time over present manually operated methods. Such savings accrue from this system's simultaneous control of multiple feeds and virtual elimination of noncutting intervals, assuring nearly 100 per cent machine productivity on even most complex parts.

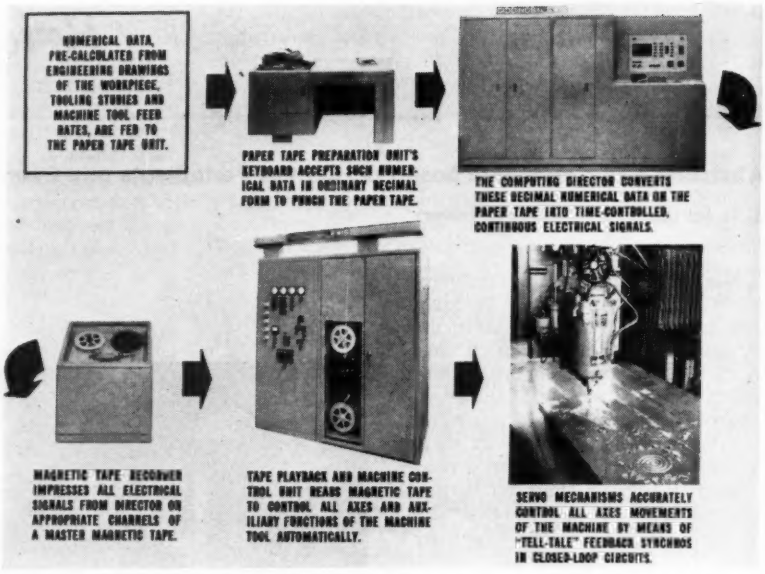

NUMERICAL DATA, PRE-CALCULATED FROM ENGINEERING DRAWINGS OF THE WORKPIECE, TOOLING STUDIES AND MACHINE TOOL FEED RATES, ARE FED TO THE PAPER TAPE UNIT.
PAPER TAPE PREPARATION UNIT'S KEYBOARD ACCEPTS SUCH NUMERICAL DATA IN ORDINARY DECIMAL FORM TO PUNCH THE PAPER TAPE.
THE COMPUTING DIRECTOR CONVERTS THESE DECIMAL NUMERICAL DATA OR THE PAPER TAPE INTO TIME-CONTROLLED, CONTINUOUS ELECTRICAL SIGNALS.
MAGNETIC TAPE RECORDER IMPRESSES ALL ELECTRICAL SIGNALS FROM DIRECTOR ON APPROPRIATE CHANNELS OF A MASTER MAGNETIC TAPE.
TAPE PLAYBACK AND MACHINE CONTROL UNIT READS MAGNETIC TAPE TO CONTROL ALL AXES AND AUXILIARY FUNCTIONS OF THE MACHINE TOOL AUTOMATICALLY.
SERVO MECHANISMS ACCURATELY CONTROL ALL AXES MOVEMENTS OF THE MACHINE BY MEANS OF "TELL-TALE" FEEDBACK SYNCHROS IN CLOSED-LOOP CIRCUITS.

Fig. 2 This block diagram indicates the main components of the Numericord system of machine-tool automation. In operation, the paper-tape preparation unit and the computing director, with its magnetic-tape recording unit, are installed in a location remote from the machining area. Thus magnetic-tape machining programs can be prepared on a production basis for all machines in the shop. Backlogs of tapes can be maintained ready to change any machine's production from one part to another without lost time. Only the magnetic-tape playback and machine-control units are located at the machine site.

Four Major Components

Four major components make up the Numericord system: (1) A paper-tape preparation unit, which punches a master numerical tape with previously calculated decimal information from part drawings, tooling data, and machine feed rates; (2) an electronic computing director which converts digital information on the paper tape into phase-modulated, time-co-ordinated command signals recorded on proper parallel channels of a magnetic tape; (3) electronic playback circuitry, which reads commands off the magnetic tape and sends appropriate electrical control signals to the machine; (4) electromechanical, machine-control units which operate in closed-loop-feedback, phase-shift, synchro-servo systems, to position machine axes in accordance with taped command signals. Machine auxiliary functions and nonfeed controls are operated automatically through relay circuits from simultaneous command impulses on other parallel tape channels.

Operation

Operation of the Numericord system is simple, practically foolproof, and extremely flexible. To prepare a master paper tape, the operator merely enters previously calculated decimal increments of desired machine axes motions and time intervals on the paper-tape unit's keyboard. No conversion into usual binary code form is necessary as the unit accepts ordinary decimal digital information. Special commands are entered on the tape in the same fashion by using six auxiliary symbols supplied. Checking circuits in the unit operate automatically to determine such command errors as exceeding feed rates or time intervals chosen, missing "plus" or "minus" signs, wrong number of digits in any command, and improper least significant digit. Other supervisory circuits examine all data fed into the unit, perforating additional holes in the paper tape for logical control of the system's electronic director unit.

"Stop" codes placed in the paper-tape sequence provide intervals for tool examination and replacement as well as for checking settings of machine verniers. Thus interruption of a machining program by tool breakage merely requires return to the first previous stop signal, retooling and restarting of the machine-control unit. Automatic operation resumes at that stop and continues to the end of the program, unless similarly interrupted.

As an example of the system's flexibility, standard engineering-type computers can be used to short-cut manual calculation of axes movements and time co-ordinates, tooling, feed, traverse, and other data necessary to program complete-part machining cycles. Such general-purpose computers usually require only the addition of readily available paper-tape punching units in their output circuits to make them usable in preparing information for the Numericord's director unit.

It is the electronic computing "director" which processes decimal digital information, contained on the paper tape, into the phase-modulated continuous electrical signals for recording on magnetic tape. In operation,

the director reads the punched paper tape, line for line, storing information thus serially presented in special magnetic-core memory units until later commands from the director release them to secondary memory units or directly to data-co-ordinating circuits for final impressing on the magnetic tape, as the program may require.

While the director is processing one group of commands, following groups are being read into it to assure continuous motion of the machine upon playback of the finished magnetic tape.

Visual indicators on the director's control panel provide one fine and five coarse data repeaters, which algebraically sum distance commands for each machine axis during a program. The fine indicator can be connected into each of the coarse circuits by pushbutton, permitting the director's operator to check positions of all tool centers at any time, just as though he were controlling the machine directly.

Control of each machine axis is accomplished by independent, closed-loop-feedback servo circuits. A movement of but 0.100 in. in a machine axis produces one complete revolution of its "tell-tale" synchro rotor.

Parallel tape channels permit simultaneous machine axes movements, together with auxiliary-function control. As examples, when a 400-cycle signal appears on a particular auxiliary function channel, drive is transferred from right to left head; when this signal disappears, drive reverts to right head. Appearance of a 200-cycle signal on another channel starts coolant flow, while on still other channels such signals automatically control oil pumps, chip conveyers, etc., or provide planned stops for both machine and tape.

The electronic playback unit, connected to the machine tool, reads all 14 channels of the magnetic tape simultaneously, sending to the machine a constant stream of signals controlling all its movements and functions in accordance with requirements of the machining program. On the skin-milling machine three Cartesian axes of the machine were under numerical tape control, plus such basic functions as "start," "stop," and traverse.

Machine axes are driven by d-c motors connected through ball-bearing nut and screw mechanisms. Synchro feedback is accomplished by parallel-mounted, precision rack and pinion gearing which accurately translates feed movement into rotation of the synchro's rotor shaft. Both drive and feedback assure minimum backlash and friction-free operation for maximum accuracy in positioning the tool head and improving finish of machined parts.

Extreme flexibility of the Numericord system is indicated by the number of ways in which it can be used. In addition to operating on numerically prepared tapes, the machine-control portion of the system can be used independently to produce its own tapes. One such method recorded machining cycles under template control. Signals are impressed on magnetic tape by machine axes synchros as they report tool-head travel. When an entire program has been recorded off template, succeeding parts can be produced by playing back the tape thus produced. Recorded tapes can be similarly produced by having the operator put the machine through simulated machining motions in a "dry run." Again synchros, attached to feed drives, record the entire program on magnetic tape just as the machine simulates it—yet with noncutting intervals of more than 20 sec eliminated to assure virtually continuous machining on playback of the tape. This method can also be used when the operator actually machines an initial part, the tape recording of which is then available to produce any number of succeeding duplicate parts automatically.

Powerama

A GIANT outdoor exposition portraying the dramatic contributions of diesel and aircraft power to America's industrial economy will be staged by General Motors Corporation on Chicago's lake front Aug. 31 through Sept. 25, 1955, according to Harlow H. Curtice, GM president.

Said to be the biggest show of its kind ever presented, the "General Motors Powerama" will be open to the public in a 1,000,000-sq ft area on South Lake Shore Drive, adjacent to Soldiers Field.

Admission to the 26-day "world's fair of power" will be free. Entertainment will range from stage shows to exhibits showing actual operation of the modern locomotive, sawmill, cotton gin, earth mover, fighter plane, and many other mechanical giants.

A lightweight, low-cost passenger train designed and built by General Motors at the request of a committee of railroad presidents will be introduced at the Powerama. This train will be able to carry 4000 passengers in "air-

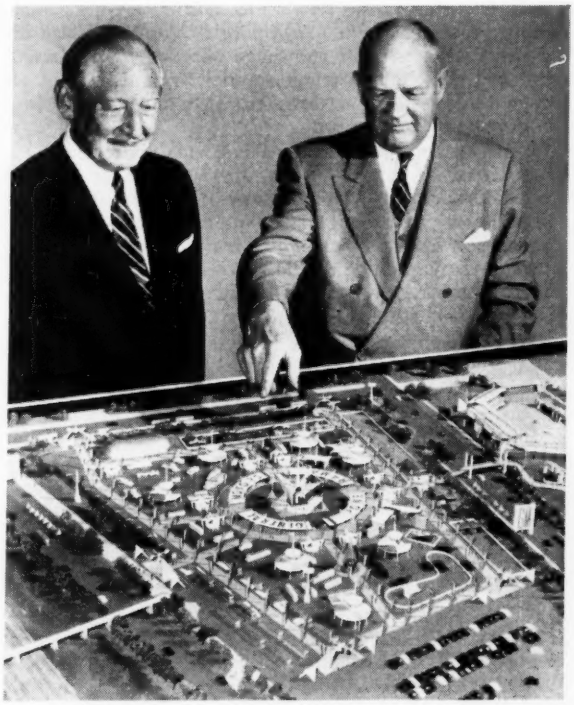


Fig. 3 Planning a giant show of diesel and aircraft power are Harlow H. Curtice, *left*, president of General Motors, and C. R. Osborn, vice-president in charge of GM's Engine Group, as they inspect a scale model of the "General Motors Powerama." The outdoor exposition is scheduled for Aug. 31–Sept. 25 inclusive, in a 1,000,000-sq-ft site on Chicago's lake front, adjacent to Soldiers Field. The Powerama will feature giant machines and other equipment produced or powered by GM's diesel, aircraft, and heavy-equipment divisions.

ride" comfort, reaching speeds of over 100 mph for sustained stretches. After appearing at the Powerama it will be demonstrated on major railroad systems.

Along a specially-built pier in a protected lagoon will be a varied array of marine equipment and craft, including a U. S. Navy submarine, a pleasure launch, shrimp boat, and many others. Visitors will be able to board these craft.

Aim of the Powerama, according to Mr. Curtice, is to unfold the seldom-heard but truly exciting story of how relative newcomers on the industrial power scene—diesel and gas-turbine engines—are giving the nation new muscles to build its roads, cut its timber, drill its wells, clear and plow its fields, propel its ships and aircraft, drive its trains, and turn the wheels of its machines.

The display will include the latest in land, air, and marine equipment produced or powered by GM diesel, aircraft, and heavy-equipment divisions. The tremendous strides being made in these fields will be the theme of the Powerama.

The show will also celebrate the production this year of General Motors' 100 millionth diesel horsepower. Within the span of just 20 years General Motors' output of diesel engines has given America more power capacity than that of all of the country's privately owned steam and hydroelectric generating plants, Mr. Curtice stated.

Also featured at the Powerama will be GM's XP-21 Firebird, first gas-turbine automobile built and tested in the United States, plus the seven experimental "dream cars" and the "dream truck" which were displayed at this year's Motorama at New York, Miami, Los Angeles, San Francisco, and Boston.

Of special appeal to women Powerama visitors will be Frigidaire's "Kitchen of Tomorrow." This experimental kitchen, designed by General Motors' stylists in co-operation with Frigidaire engineers, contains such features as panels that open at a wave of the hand and a television set on which the busy housewife can—without leaving the kitchen—see what the youngsters are doing elsewhere in the house.

But the high lights of the Powerama will be the large dump trucks, locomotives, scrapers, tractors, boats, and a variety of engines and other equipment.

This equipment will be available for close-up inspection and many of them will go through their paces in actual operation.

GM divisions which will exhibit at the Powerama will include Allison, Cleveland Diesel, Detroit Diesel, Diesel Equipment, Electric-Motive, Euclid, Fabricast, Frigidaire, and GMC Truck & Coach.

Here are a few of the exhibits planned for the Powerama:

The world's largest dump truck; an M-48 tank with the control apparatus outside where spectators can watch an operator control the steel monster; a full-scale model of a vertical-rising aircraft, showing how the "Pogo" plane takes off "straight up"; an F-89 "Scorpion" fighter plane; an oil-drilling rig in actual operation; an operating sawmill, cutting up giant timber; an operating cotton gin; a high-speed diesel locomotive, mounted so that it will "run" without moving; a full-scale exhibit showing all the steps in building an actual road; and a GM diesel engine used in the world's fastest submarine.

Fig. 4 Applying Norton ROKIDE "A" pure-oxide coating with a metalizing-type spray gun

Refractory Coatings

A NEW line of pure-oxide refractory coatings which have commercially proved their ability to protect metal parts from higher temperatures than have heretofore been possible was unveiled recently by Norton Company of Worcester, Mass.

Scientists throughout the world have reached the point in the development of heat engines where available metals melt or lose their strength. At this transition point in engineering design, substitute materials such as ceramics can sometimes be used. In other cases, protective coatings can be applied to the metals. Norton ROKIDE pure-oxide coatings have been successfully tested in a wide range of field applications for protecting metals from the effects of high temperatures and corrosion.

ROKIDE coatings are of two types; aluminum-oxide coatings on a wide range of base materials, particularly metals, and silicon carbide on graphite base materials.

Applied in Molten State

ROKIDE aluminum-oxide coatings are applied in a molten state by means of a metalizing-type spray gun. The oxide is fed into the gun in rod form at a carefully controlled rate. Thickness of coating is usually between 0.005 and 0.050 in. although coatings 0.100 in. thick have been applied successfully. The coating can be applied to practically any materials but it is most commonly applied to metals. It is extremely hard, has good wear and chemical-resistant qualities, is a nonconductor of electricity, and weighs about half as much as steel. Once applied to metal, the oxide coating will not chip or flake off even under severe tests. In an experiment, a piece of metal with a coating 0.010 in. thick was placed on a railroad track and run over by a locomotive without cracking off the coating. Metal samples have been bent to 90-deg angles without chipping the coatings.

Silicon-carbide coatings have been applied successfully only on graphite shapes up to the present time. While graphite has many desirable properties for use in rockets, it will not withstand high temperatures or erosion adequately. However, a thin coating of silicon

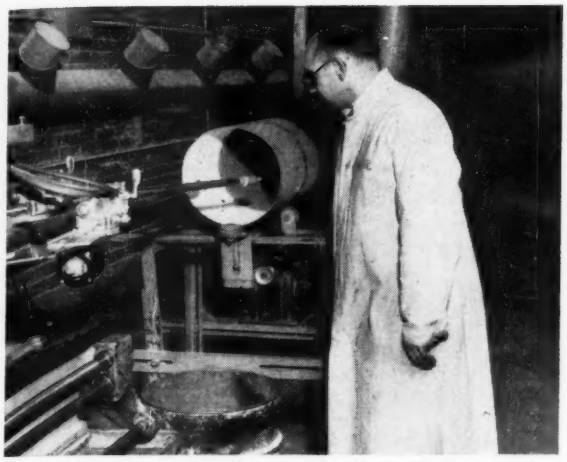


Fig. 5 Automatic application of Norton ROKIDE "A" pure-oxide coating to inside surface of experimental ramjet part

carbide provides the needed protection with a negligible increase in weight.

Norton products for reaction motors have the following general properties and characteristics: Very high melting point, extremely hard, relatively chemically inert, good mechanical strength, large ranges of shapes and sizes available, high resistance to corrosion, dimensionally stable, close tolerances can be maintained, low coefficient of expansion, resistance to mild impact.

The following are a few applications that have shown exceptional promise: In rockets—nozzles, motor-tube linings, thermal barriers. In guided missiles—vanes, skin protection, motor components. Ramjets—tail pipe linings. Gas turbines—inner-combustion-chamber lining, cross-fire tube lining, flap-nozzle coating, housing and shroud-ring insulation. Miscellaneous—burner parts protection, electrical, insulation, thermocouple-tube protection.

Field Performance

At the present time, tests are being conducted in many applications under a variety of conditions. An indication of performance results are indicated in the following report:

"A maximum temperature drop of 1500 F has been reported through 0.010 in. thickness of aluminum oxide coating under certain conditions by a manufacturer of power plants for guided missiles. This product has also been reported as useful with both solid and liquid propellants, and capable of withstanding erosive and corrosive conditions in nozzles for high-velocity reaction motors."

Research-Reactor Sales Program

A CO-ORDINATED industrial sales program for nuclear-research reactors, said to be the nation's first, was launched in July by the General Electric Company's new atomic-power equipment department.

The new "seven-point research-reactor program" will help industrial, educational, and research organizations to plan and obtain nuclear-research reactors in the shortest possible time, according to O. B. Falls, Jr., manager of the department's marketing section.

The seven steps which the department will take in helping customers to obtain and operate reactors are as follows:

1 Prepare reactor specifications, meeting specific research requirements.
2 Co-ordinate building study, assuring proper housing of reactor.
3 Prepare Hazards Summary report to aid in obtaining AEC approval.
4 Manufacture reactor on schedule.
5 Install reactor system at buyer's location.
6 Start up reactor, assuring proper operation.
7 Provide reactor service to maintain reactor system in proper working order.

Reactors listed which General Electric is equipped to sell under this program and their maximum power ratings are: Nuclear test reactor, 30 kw; water-boiler reactor, 50-kw; swimming-pool reactor, 1000 kw; heavy-water reactor, 5000 kw.

All four can be used as neutron beam generators, for the production of radioactive isotopes, for irradiation purposes, and for nuclear-engineering studies. Use of the reactors will be governed by the Atomic Energy Act of 1954.

In addition, General Electric is equipped to design and manufacture components for nuclear-reactor systems, including control systems and components, remote handling equipment, coolant-system components, and reactor service equipment.

Geneva Research Reactor

THE research reactor the U. S. Atomic Energy Commission will exhibit at the International Conference for Peaceful Uses of Atomic Energy was airlifted to Geneva, Switzerland, from Knoxville, Tenn.

The reactor was flown over in two U. S. Government aircraft and reassembled on the grounds of the Palais des Nations, where the conference will be held from Aug. 8 to 20, 1955.

Built in a record three months at Oak Ridge National Laboratory near Knoxville, the reactor was successfully tested, passing all safety requirements, before it was dismantled and crated for transatlantic airlift.

The Oak Ridge National Laboratory is operated under contract with the AEC by Union Carbide and Carbon Corporation.

The reactor will be located in a new building at Geneva especially built for it.

Delegates will be invited to watch demonstrations and experiments of the reactor. It is expected there will be special hours when the public also will be invited to attend. This will be the first United States' reactor to be exhibited in Europe. It is one prototype of research reactors which will become available to more than 20 nations under the bilateral agreements which the United States has been signing in recent weeks with individual nations. After the Geneva Conference, the reactor will be sold to the Swiss Government.

A pool-type reactor, at Geneva it will operate in a cylinder of purified water 10 ft in diam and 21 ft deep. The reactor operates with approximately 18 kilograms of uranium containing 3.6 kilograms of U-325 isotope. This represents the 20 per cent enrichment of the fuel, insufficient to make it of weapons grade.

The reactor underwent a variety of operational and safety tests at Oak Ridge, each of which was satisfactory. The reactor's power rose to a maximum level of 100 kw of heat. It operated at full power for a total of 25 min during the several hours of tests.

As a result of advances in instrumentation, it is possible for this reactor to be operated automatically from start to full power. Laboratory engineers point out that adaption of this design will add more safety factors for reactors of this type now under construction both in the United States and abroad.

Isotope Bibliography

AN ANNOTATED bibliography reviewing the applications of radioactive materials to the metals field has been compiled by G. G. M. Carr-Harris, Mem. ASME, associate research officer, National Research Council of Canada, Ottawa, Ont., Can. The report "Metals Engineering and Radioactive Materials," (National Research Council, T. I. S. Report No. 42), cites more than a hundred references, papers, articles, and books published during the past two years which are of specific interest to metallurgists and metal-industry engineers.

The industrial applications of isotopes are classified under two basic headings: As a source of radiation energy "to penetrate metals, ionize gases, and induce or accelerate chemical reactions"; or as tracers "to carry out studies which would be either impossible or time consuming by conventional methods."

According to Mr. Carr-Harris, already great progress has been made in the radiographic inspection of metals using radioisotopes. Apart from instrumentation, however, it is still too early to predict what practical applications can be found for them in ionizing gases, and their ability to induce chemical reactions has yet to be exploited in metallurgical work.

Tracer applications in the metal industry have ranged from study of a salt-water corrosion problem with a zinc-magnesium alloy to diffusion studies of carbon penetration in steel, and wear tests on cutting tools. Radiography examples cited in this bibliography include weld inspection, detection of hydrogen blisters in steel tanks, and checks for microporosity in castings.

Under instrumentation, the bibliography cites applications of isotope equipment for gaging sheet metal, measuring fluid density, viscosity determination, and bulk density of granular solids.

Impact Tube

A NEW instrument for measuring the effect of impact on metals and plastics has been developed in the Research Division of the New York University College of Engineering.

Called the "impact tube," the instrument describes impact in terms of dynamic stress-strain relationships. Stress-strain results from past studies have been mixed with the effects of waves propagated by sudden shock. In the new instrument the two elements are separated.

Discussed in the June, 1955, issue of the NYU "Engineering Research Review," the instrument consists essentially of a 14-ft-long steel tube 18 in. in diam. The tube is divided into three chambers, a static chamber, dynamic chamber, and firing chamber. The test specimen, a circular metal plate, is mounted between the static and dynamic chambers.

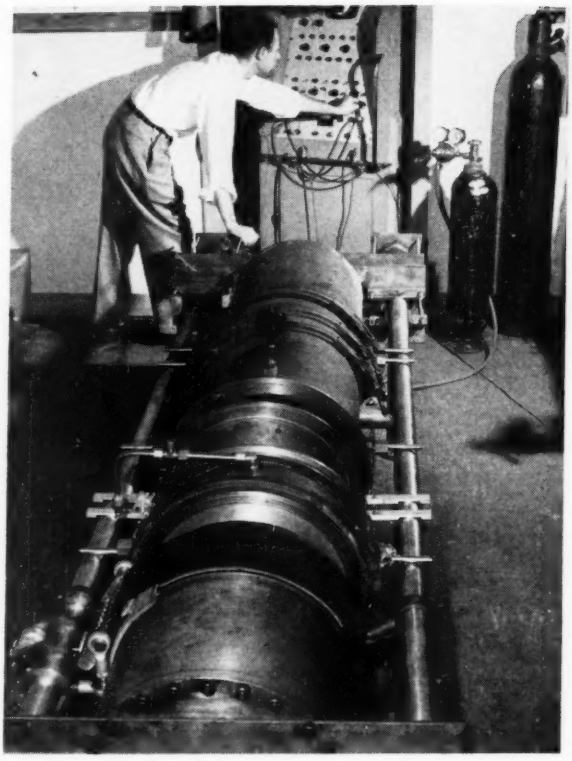


Fig. 6 A New York University research engineer adjusts the oscilloscope before an experiment with the impact tube, a new instrument for obtaining dynamic stress-strain relationships in metals and plastic subjected to sudden impact. The device consists of a firing chamber, *foreground;* dynamic chamber, *center;* and static chamber, *rear.*

The other end of the dynamic chamber is sealed with a plastic diaphragm supported by a pneumatically controlled piston. Pressure is built up equally in the static and dynamic chambers.

Impact is applied by a carefully controlled simulated explosion. First, the diaphragm is ruptured. This sends an expansion wave from the mouth of the dynamic chamber to the specimen. Pressure at the specimen position drops in about 0.01 sec. The onrushing pressure from the static chamber slams against the specimen. This constitutes the impact loading. The force of the impact can be varied by changing the length of the dynamic chamber.

Knowledge of the stress-strain response of metals and other materials is essential in the design of structures subject to sudden loads. These include supersonic aircraft, equipment and buildings that may be under bomb blast, the landing gear of aircraft, even automobile parts that are stamped out by heavy presses.

Information on how materials react under static loading (slowly applied) is so extensive that, as a matter of course, the static response of various materials is tabulated and supplied by metals and plastic manufacturers to engineers working with the material. With further development of impact-tube techniques, data on stress-

strain relationship of materials under sudden loads may be as commonly disseminated.

Wave-propagation effects in the impact test are minimized by the flatness, or planarity, of the expansion wave created in the dynamic chamber. With the new instrument, the effect of impact can be measured over the entire face of the specimen. Information is transmitted from pressure gages and transducers attached to the specimen and an oscilloscope. Signals on the oscilloscope are photographed as they move across the screen.

To date, scientists in the NYU Engineering Research Division have studied the response of aluminum, steel, and titanium alloys to various loads and loading speeds.

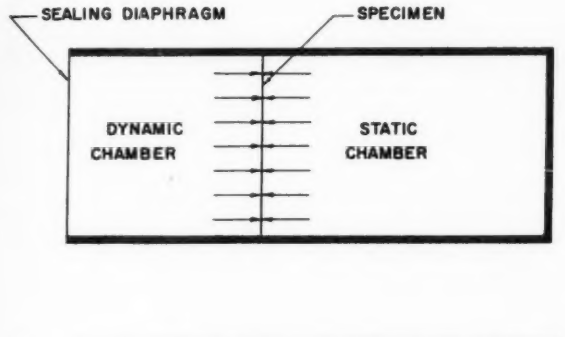


Fig. 7 Impact-tube operation. ***Top:*** **Specimen in position with pressure applied to both chambers.** ***Bottom:*** **Sealing diaphragm ruptured and specimen loaded impulsively.**

Dr. George Gerard, Assoc. Mem. ASME, assistant director of the Engineering Research Division, invented the impact tube. Research is being conducted under sponsorship of the Office of Ordnance Research, United States Army.

Tree Crasher

A HUGE "tree crasher," traveling on the largest rubber tires in the world, has been purchased for major land-clearing work along the Florida-Georgia line by Handly Construction Company of Pahokee, Fla. The tree crasher was designed and built by R. G. LeTourneau, Inc., of Longview, Texas.

Designed to uproot heavy trees and underbrush with pushbutton ease, the six-wheeled vehicle is said to have three times the wallop of an M-24 tank, yet is so light on its feet that it can roll over a pocket watch without damaging it.

Wheels of the machine each measure 4 ft wide and 10 ft in diameter.

Observers say the unit may well cause major changes in present-day land-clearing practices.

In operation, the operator, perched in a balcony-high cab and fingering trigger-sensitive electric switches, maneuvers the machine directly into a large-size tree with the blade raised about 10 ft in the air. Almost without hesitation the tree bends, strains, then lifts its own roots as it crashes to the ground.

For smaller, medium-size trees, the machine goes in with its blade lowered, uprooting and carrying away trees and underbrush in one continuous operation.

Design of the vehicle is such that each of the six mammoth wheels has within its rim an individual electric motor and gear reduction. These motors are driven by generators which, in turn, are driven by two giant diesel engines near the center of the unit.

Secret of the light "weight" of the 120,000-lb vehicle lies in its tires—each of which is reported to cost something over $5000. Because of their gigantic dimensions, and because they can operate with air pressures as low as 5 lb, the actual per-square-inch weight of the machine upon the ground is about the same as that of a walking man.

Such an extreme degree of "flotation" and the powerful motors for each wheel make the unit particularly well suited for work in swampy or sandy areas where other types of equipment would find it impossible to operate.

Another application which probably will develop for the machine is that of transporting heavy loads over rough terrain. The top of the crasher forms a convenient platform 39 ft long and 11 ft wide, which, LeTourneau engineers stated, is capable of supporting more than 200,000 lb.

Fig. 8 Resembling a rubber-tired flatcar, except much larger, the tree crasher is shown on the testing grounds of its manufacturer, R. G. LeTourneau, Inc., of Longview, Texas. Compare size of the vehicle with operator, leaning out of cab to receive directions from president of the firm, R. G. Le Tourneau, Fellow ASME, in foreground.

Magnamatic Screw Driver

A NEW torque-controlled Magnamatic screw driver has been developed by Chicago Pneumatic Tool Company. This new tool permits desired torque to be applied consistently over high production runs without reliance on operator skill, with increased tool life, and at higher production rates. It is equally well suited to single or multiple-spindle screwdriving operations, depending on the degree of automation required in the particular application involved.

Unlike air-motor-driven or mechanical-clutch-operated screw drivers the Magnamatic "one-shot" clutch disengages fully the instant proper torque is attained, and stays disengaged until the screw driver or nut runner is removed from the work. The human element in determining proper fastener tightness is removed entirely from the driving operation. Because the clutch jaws re-

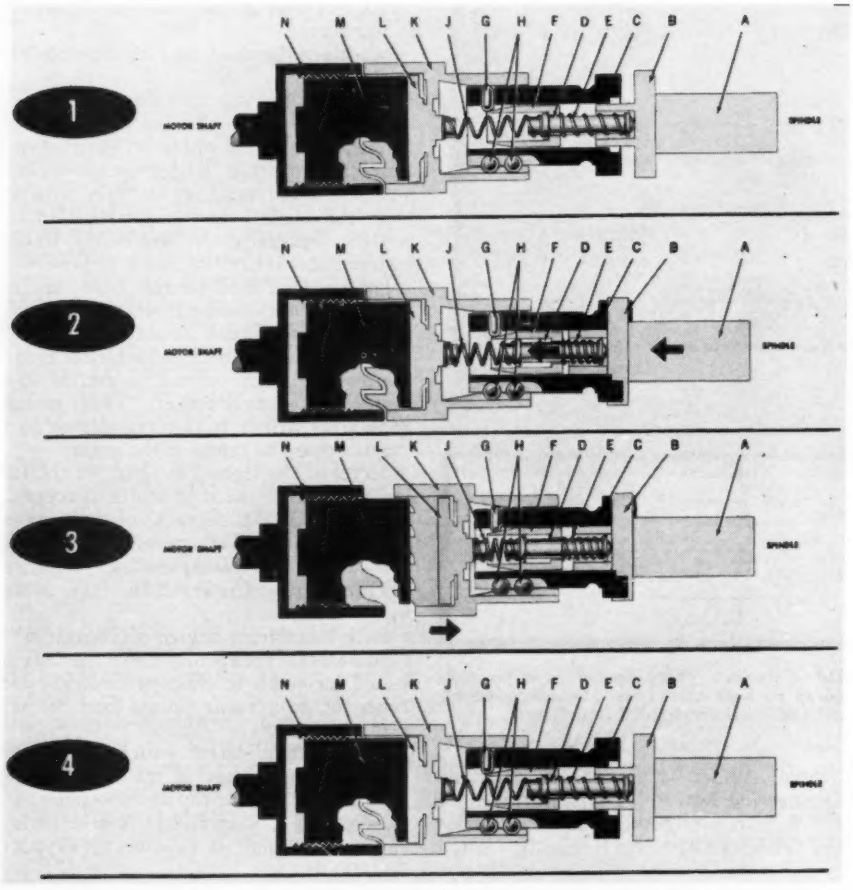


Fig. 9 Design and operation of the Magnamatic screw driver. (1) With no axial pressure on spindle, spring (J) holds latch pin (D) forward. Pin holds positive clutch pin (B) forward and disengaged from positive clutch jaw (C). Magnet (M) holds armature plate (L), keeping torque clutch lower jaw (K) engaged with torque clutch upper jaw (N). In this position all parts rotate except hex drive spindle (A) and pin (B). The spindle is, therefore "dead." (2) With tool on work, axial pressure is applied. Hex drive spindle (A) is forced rearward, engaging pin (B) with jaw (C). Drive shank (A) is thus rotated, driving the screw home. Moving rearward, clutch pin (B) pushes latch pin (D) to the rear, compressing spring (J). Latch sleeve (F) is prevented from moving rearward by lock pin (G) and spring (E) is, therefore, compressed. (3) At desired torque, lower jaw (K) cams out of upper jaw (N) against the pull of magnet (M). When distance between armature plate (L) and magnet reaches about 0.015 in. magnet pull is overcome and camming throws jaw (K) further forward. When jaw (K) moves forward, its inside taper lets lock pin (G) be moved outward by tapered sleeve (F) which is pushed rearward by spring (E). Pin (G) wedges on taper of jaw (K), keeping it from engagement with jaw (N). Thus jaws disengage instantly at desired torque and positively lock out of engagement, preventing further torque build-up no matter how long tool is held on work. (4) With tool removed from work, spring (J) pushes pin (D) forward, disengaging pin (B) from jaw (C). Latch sleeve (F) also moves forward. Taper on sleeve lets lock pin (G) be pushed in toward axis by taper on lower jaw (K). Lower jaw moves rearward until armature plate (L) contacts magnet (M). Torque clutch is engaged by magnet until the next screw is driven to proper torque. Parts are now in position as in (1), and the tool is ready for the next screw.

Fig. 10 New Magnamatic screw driver consistently drives screws to desired torque in a rheostat. The new clutch eliminates the bothersome racheting of conventional drivers and prevents stripping of fasteners.

main separated, objectionable racheting or impacting action, and the other undesirable features found in conventional clutches are eliminated.

The Magnamatic screw driver offers these features:

1 Desired tightness or torque is automatically achieved without reliance upon operator skill.

2 The life of clutch components is greatly increased, due to the absence of any hammering action. (Fifteen months on high-production assembly lines driving thousands of screws daily without showing appreciable clutch wear, no parts replacement other than inexpensive retaining rings.)

3 Screw bits last as much as 20 times longer due to the total absence of impacting.

4 Damage to screw heads and surface finishes of products is greatly diminished.

5 Objectionable noise of impacting clutch is eliminated. In the past, because of the uncertainty of obtaining proper tightness, the tendency has been to resort to the expensive practice of using screws that are larger than necessary. For example, many products use a $^1/_4$-in. screw operating at 20 per cent of its full tightness, when actually a $^1/_8$-in. screw tightened to 80 per cent of its breaking point will do the job with obvious added weight and cost benefits.

Waterflooding Projects

Newly developed methods of injecting water into underground petroleum reservoirs to force oil to producing wells are described in a recent Bureau of Mines report.

The report describes five waterflooding projects—one pilot, or test, operation and four full-scale ones—recently begun in the Delaware-Childers and Curl Creek fields of Nowata County, Okla. Waterflooding generally has proved the most efficient method of recovering oil in fields where the natural reservoir pressures are exhausted, although injection of air or gas also proved successful.

The five operations in Nowata County were visited May 18 by oil producers, engineers, and others interested in secondary oil-recovery techniques during a Bureau-sponsored tour of successful waterflooding projects in Oklahoma. Such tours have been conducted annually for several years to stimulate interest in secondary recovery, and hence to promote conservation of petroleum.

Substantial increases in rates of oil production have resulted at all of the waterfloods discussed in the present report. However, the projects have not been active long enough to permit an accurate evaluation of their ultimate benefits.

The pilot operation in the Curl Creek field utilizes a portable "package" plant with centralized controls. This is so designed that it can be moved easily, if the project is unsuccessful or if the pilot is to be replaced by a larger one.

All of the full-scale operations discussed in the report are in the Delaware-Childers field. One employs a treatment plant with a daily capacity of 50,000 bbl of water, where water is chemically conditioned before injection underground. Chemical treatment pays off in better oil recovery.

Each of the projects described has one or more novel features which make it of interest to oil producers and production engineers. For each project, the report gives the source and treatment of water used for flooding, a brief history of the project, and a development map of leases, production data, typical core analyses, water analyses, and drawings of the water-treating plants.

A copy of R.I. 5134, "Recent Developments in Waterflooding in Nowata County, Okla., Oil Fields, 1954-55" by J. L. Eakin, can be obtained from the Bureau of Mines, Publications Distribution Section, 4800 Forbes Street, Pittsburgh 13, Pa. It should be identified by number and title.

All-Weather Demon

The U. S. Navy and the McDonnell Aircraft Corporation of St. Louis, Mo., announce the delivery of the first F3H-2N Demon, a powerful single-jet carrier-based fighter. The new Demon is the first airplane to have the Navy gray and white color treatment.

A newer, more powerful turbojet engine, the Allison J-71, will power the F3H-2N. In the 10,000-lb thrust class, this engine was developed to provide good fuel economy with maximum thrust output. An afterburner installation augments the engine thrust considerably. The Westinghouse J-40 propelled the F3H-1N.

Like its predecessor, the F3H-1N, the new Demon is an all-weather, high-performance fighter combining interceptor speed and fighter maneuverability with the pay load of an attack bomber. Thin wings and tail surfaces are swept sharply back to place the big fighter in the 600-mph speed class.

The large internal fuel capacity provides the Demon with the range necessary for fighter-bomber missions.

Rapid-firing, high-velocity 20mm cannon as well as a

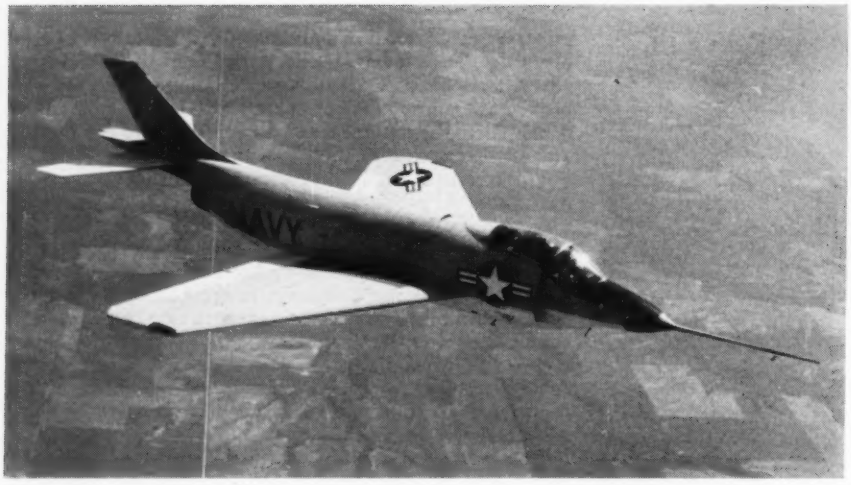


Fig. 11 New, more powerful McDonnel Demon, with the Navy's recently adopted gray-and-white color scheme and the Allison 10,000-lb thrust J-71, with afterburner, is now in production at St. Louis

large number of rockets and combinations of external stores make the Demon a formidable aerial weapon. Improved radar and latest developments in computing and fire-control equipment enable the fighter to operate under all weather conditions.

The Navy's new color treatment of the fighter's exterior consists of the application of a dull-finish gray to the top of the wings and fuselage and a glossy white to the underside.

Now under production at the McDonnell plant, the new Demon series is scheduled for delivery to Navy operational units through 1956.

Commercial H-21 Helicopter

A COMMERCIAL version of the H-21 "Work Horse," the large, heavy-duty helicopter now in service with the U. S. Air Force, U. S. Army, and Royal Canadian Air Force, will be built for airline and industrial use by Piasecki Helicopter Corporation, designer of the twin-rotor craft. The civil version, scheduled for initial delivery in 1956, will be known as the PH-42.

New York Airways, Sabena Belgian Airlines, and other operators are currently evaluating the H-21 as a possible replacement for their present lower-capacity helicopters. The civil version of the H-21 will seat 19 passengers. Civil Aeronautics Administration certification procedures on the H-21 are currently under way.

The H-21 is the highest-performing helicopter now in extensive military service, with a maximum economy cruising speed of 98 mph and an alternate cruising speed of 109 mph. The passenger cabin is, for a helicopter, roomy and spacious, measuring 20 ft long, nearly 6 ft high, and over $5\frac{1}{2}$ ft wide. A forward door on the right and a rear door on the left facilitate loading and unloading.

One of the outstanding advantages of the H-21 is that passengers may sit wherever they desire, since no special consideration in regard to aircraft balance is required. The tandem-rotor design—a lifting rotor at each end of the aircraft—makes this possible.

The civil version of the H-21, the PH-42, will be made available in a variety of seating arrangements—ranging from a deluxe 16-seat version to the 19-seat model—as well as in passenger-cargo and all-cargo versions.

Fig. 12 The Piasecki PH-42 (commercial version of the H-21 helicopter) which comfortably seats 19 passengers, incorporates several features designed to increase frequency of service, a vital consideration in commuter service. These include built-in steps to eliminate time-consuming positioning of steps by ground attendants at each stop; doors on both sides to speed loading and unloading; and an external Helipack into which passengers can place their baggage as they enter. The 80-cu ft Helipack can also be used for mail.

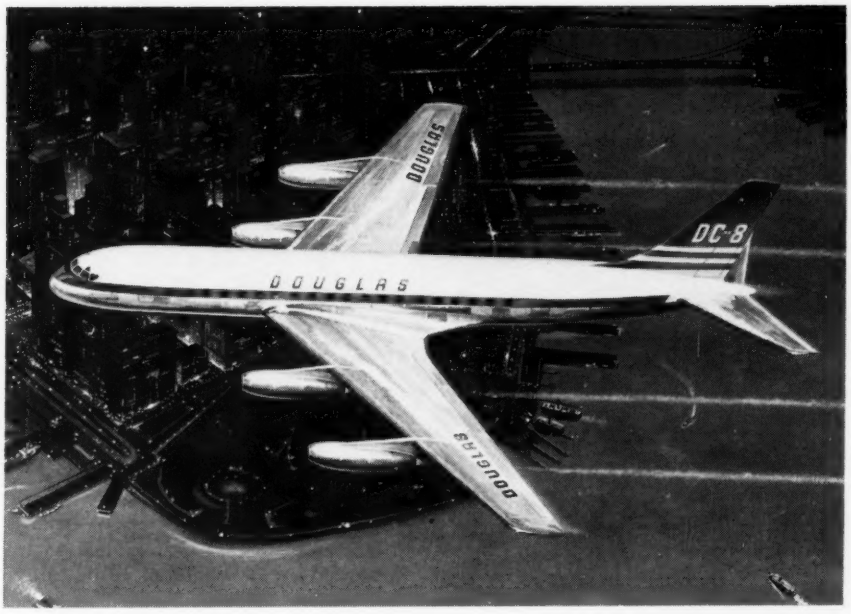


Fig. 13 Artist's conception of proposed DC-8 swept-wing jet airliner

The PH-42 can carry mail and baggage externally in a detachable "Helipack" under the fuselage, thus making available additional cabin room for passenger comfort. In addition, the external pack will serve to speed loading and unloading as passengers can place their baggage in the 80-cu ft pack before entering the cabin. This avoids doorway congestion and delays which would be experienced if luggage had to be stowed in the cabin.

Swept-Wing Jet Airliner

AMERICA's first commercial passenger jet transport is to be built by Douglas Aircraft Company, according to a recent issue of "Douglas Airview News."

The swept-wing jet airliner will have a top speed of more than 550 mph, carry 80 to 125 passengers, and be capable of regular nonstop flights between the United States and European cities regardless of adverse winds. It will be able to fly from Los Angeles to New York in $4\frac{1}{2}$ hours, New York to Paris in $6\frac{1}{2}$ hours, and Honolulu to San Francisco in a little over 4 hours.

The new, ultrahigh speed transport will be known as the DC-8 and will be ready for initial test flight by December, 1957, with airline deliveries beginning in 1959.

It will be powered with an advanced version of the Pratt & Whitney J-57 engines which, the company said, had been thoroughly proved with thousands of hours in military service.

The DC-8 will be nearly 200 mph faster than the DC-7 "Seven Seas" model scheduled for deliveries to eight leading airlines beginning in 1956.

In spite of its tremendous size, speed, and performance capabilities, the Douglas jet transport will be able to operate from existing major air terminals at operating costs even lower than current airliners.

Gross weight of the overwater version of the new airliner will be 257,000 lb. The domestic version, with less fuel capacity, will have a 211,000-lb gross weight.

Span of the DC-8's swept wings will be 134.6 ft, length 140.6 ft, and over-all height 40.2 ft.

Technical investigations and engineering development of the jet transport have been in progress for more than three years, according to Douglas. In some departments actual work on the Douglas DC-8 has already begun.

How to Obtain Further Information on "Briefing the Record" Items

Material for these pages is assembled from numerous sources and aims to cover a broad range of subject matter. While few quotation marks are used, passages that are directly quoted are obvious from the context, and credit to original sources is given.

This material is abstracted from: (1) technical magazines; (2) news stories and releases of manufacturers, Government agencies, and other institutions; and (3) ASME technical papers not preprinted for meetings. Abstracts of ASME preprints will be found in the "ASME Technical Digest" section.

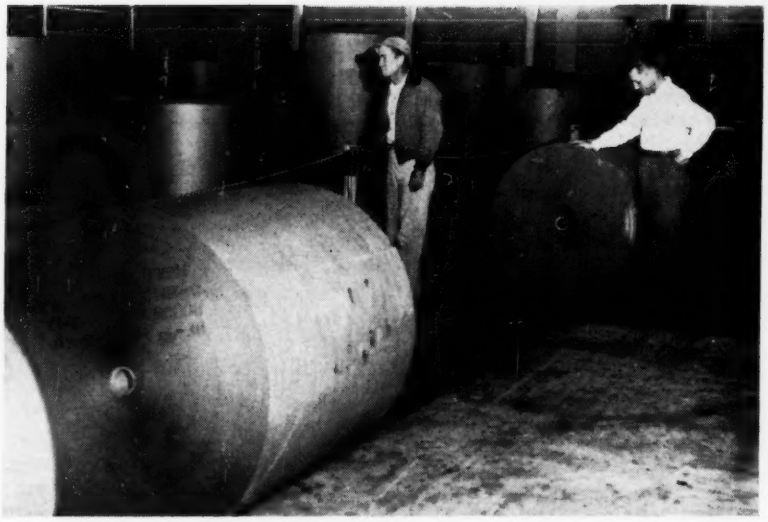
For the texts from which the abstracts of the "Briefing the Record" section are prepared, the reader is referred to the original sources; i.e. (1) The technical magazine mentioned in the abstract, which is on file in the Engineering Societies Library, 29 West 39th St., New York 18, N. Y., and other libraries. (2) The manufacturer, Government agency, or other institution referred to in the abstract. (3) The Engineering Societies Library for ASME papers not preprinted for meetings. Only the original manuscripts of these papers are available. Photostat copies may be purchased from the Library at usual rates, 40 cents per page.

Steam-Plant Coal Feeding. A network of nearly three miles of rubber conveyer belts, operating in four directions at once, keeps 1400 tons of coal an hour flowing into the Shawnee electric-power-producing steam plant near Paducah, Ky. In this view of the plant, looking south from the Ohio River, the barge unloading dock is in *foreground*, condenser cooling-water-intake channel is at *left*, and discharge channel at *right*. The conveyer-belt system, supported by towers, crosses the latter channel on the 2640-ft trip from river to crusher building at the plant site. Drumlike structures near the river's edge are mooring sites for coal barges. Manufactured and installed by The B. F. Goodrich Company, Industrial Products Division, Akron, Ohio, elevated sections of the belt speed over land on towers raised as high as 50 ft above the ground. The belts go up steep grades, span a river channel and road, probe underground for short runs to reach a 1,450,000-ton stock-piling area. Coal hauled by the beltroad supplies 14,000 tons of fuel a day for the plant's ten 150,000-kw units. The electricity is fed to the gaseous diffusion plant operated by the Atomic Energy Commission at Paducah. The maze of belts is controlled electronically by one man.

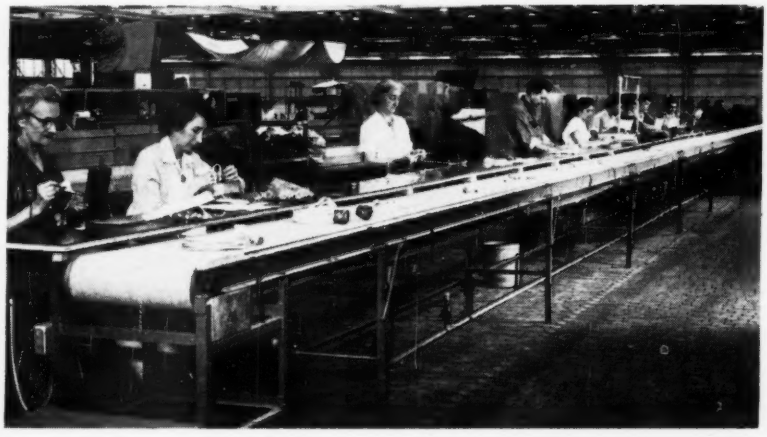
Materials-Handling Equipment . . .

. . . *increases production, saves space, reduces costs*

Handling in Congested Machining Area. Palletization and use of a battery-powered, hydraulically operated pallet truck provided the answer for moving heavy parts to and from machining stations located in a congested, narrow-aisled area at Waukesha Motor Company, Waukesha, Wis. Parts are stacked on wooden pallets in 5000-lb loads and moved from one operation to the next. After each operation parts are replaced on pallets. Pallet truck needs little room to maneuver, can operate in narrow aisles with full load. *Left* photo shows Clark Powrworker positioning pallet load of crankshafts. Storage area, carefully arranged to coincide with production rate, permits utilization of all space. *Right* photo shows Powrworker dropping load of motor cases for boring operation. Load is lowered as machine inches into position under hoist.

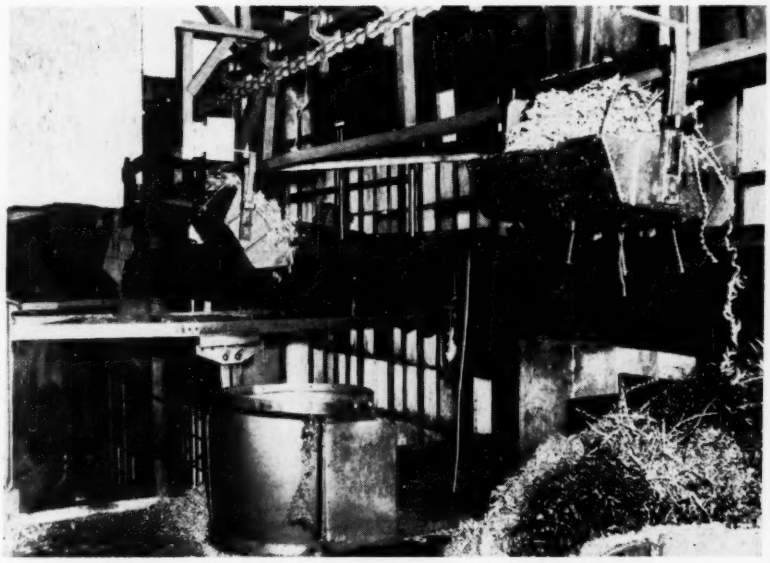


Moving 1200-Lb Paper Rolls. This moving rubber sidewalk effortlessly carries these 1200-lb paper rolls from paper mill to an adjoining bag plant where they are converted into paper bags of many types. The rubber belt, manufactured by The B. F. Goodrich Company Industrial Products Division, Akron, Ohio, is 10 in. wide, 445 ft long, and capable of hauling 10,000 lb at a time. The belt runs on closely spaced steel rollers. One of two such moving rubber sidewalks at St. Regis Paper Company, Bag Division, Pensacola, Fla., the belt shown has been in operation nearly two years.



Making Plug and Wire Assemblies. Plug and wire assemblies for aircraft electrical and electronic systems are now made at Martin in Baltimore, Md., on an assembly-line conveyer. There are thousands of wires in an aircraft system, and as many as 30 are soldered to one connecting plug. Using the belt conveyer permits assembling these units in record time. The line-stocker arranges the flow of work and supplies the parts. A container of electrical plugs and fittings is delivered to the operator at the head of of the conveyer. Here, coils of wire are arranged ready for use. As many as 60 plugs can be assembled simultaneously on this belt conveyer.

Metal-Chip Removal. About 35 tons of metal chips are loaded daily into gondola cars by this continuous conveyer system at the New Process Gear Company, Syracuse, N. Y. The conveyer, installed by Lamson Corporation, Syracuse, N. Y., is loaded manually at the central chip bins in the basement. From that point it travels up and out over a railroad siding, where the chips are dumped into a waiting gondola car automatically. The metal chips are collected from the machines on each floor by hand trucks which empty them into hoppers in the basement where the oil drains off. The chips are then shoveled into the flat-bottomed pans mounted at 10-ft spacings on a 4-in. Lamson trolley conveyer which passes through the hoppers. Each pan carries about 40 lb of chips. The loaded pans travel up through the fourth floor and over a line of gondola cars, where the pans are automatically emptied.



European Survey

Engineering Progress in the British Isles and Western Europe

J. Foster Petree,[1] *European Correspondent*

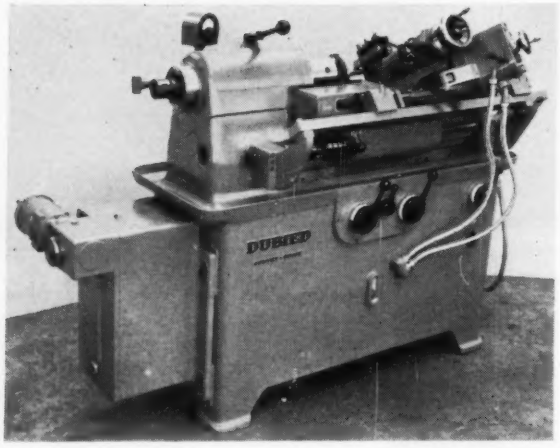


Fig. 1 Rapid copying lathe with constant cutting speed and constant feed per revolution

Copying Lathe

THE Swiss firm of Edouard Dubied & Cie, S.A., of Neuchatel, who have specialized for a number of years in the manufacture of rapid copying lathes, showed at the recent Swiss Industries Fair a new model, the Dubied 515, illustrated in Fig. 1. In external appearance, it does not differ greatly from some previous types produced by the firm, but the performance is considerably improved by providing a steplessly variable hydraulic feed which maintains a constant cutting speed as well as a constant feed rate, irrespective of changes in the diameter of the work. The initial speed is selected by the operator to suit the diameter at which cutting is to begin, and the nature of the material being machined; after this has been done, further operation is entirely automatic. The spindle speed is controlled by an electrical servomechanism coupled to the toolslide. This servo gear has a range of speed regulation of 1:7 and applies that full regulation in 4 seconds. The hydraulic system comprises three pumps; one draws from the large oil sump that forms part of the cast-iron bed of the machine and delivers the oil to the second pump, which is the regulating unit supplying the feed cylinder; it is in hydraulic balance and delivers a constant preset quantity of oil irrespective of load, temperature, and viscosity, thus insuring a constant feed movement. The third pump supplies oil to the hydraulic copying device. The feed is controllable by means of the hydraulic regulating valve. On completion of the cut, the tool is withdrawn automatically from the work and toolholder carriage is automatically returned to the starting position by the quick-acting return motion, which operates at a fixed rate of 4000 mm (158 in.) per min.

The machine is made in two sizes, the 515/400 and the 515/650, having a distance between centers of 400 mm and 650 mm, respectively. Except in this respect, the two models are identical, having a height to the center of 120 mm, a cross-slide travel of 75 mm, and a copying-tracer travel of 50 mm. The maximum diameter that can be turned is 110 mm ($3^5/_{32}$ in.). A choice of spindle-speed ranges is offered, the machine being supplied, at the customer's option, with drives to give spindle speeds from 300 to 2100 rpm or 570 to 4000 rpm. The spindle is driven through multiple V belts by a 7-hp motor. A separate motor, of $^3/_4$ hp, drives the pumps. The top of the bed is sloped toward the back of the machine, so that the swarf falls or is easily swept into a wheeled bin which is designed to fit under the rear guard.

Automatic-Turret Lathe

ANOTHER new machine shown at the Swiss Industries Fair in Basel was the BR-20 high-precision automatic-turret lathe illustrated in Figs. 2 and 3, exhibited by André Bechler A.G. Maschinenfabrik, Moutier, Switzerland. It has a capacity for stock up to 20 mm (0.788 in.) in diam and has a maximum turning length, depending on the equipment supplied, ranging from 70 mm to 205 mm ($2^3/_4$ in. to slightly more than 7 in.). Smaller sizes are available, with capacities of 12 mm and 16 mm,

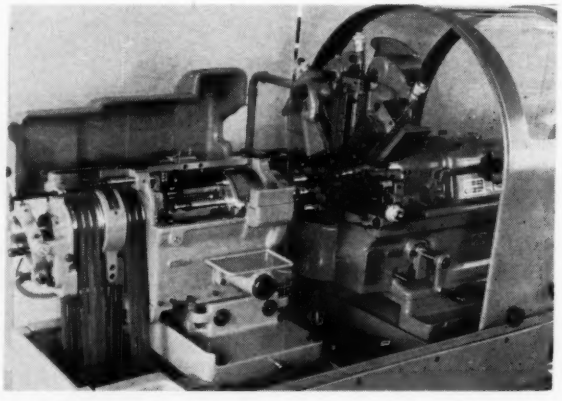


Fig. 2 BR-20 Automatic-turret lathe. Front of machine showing 6-spindle drum turret and 5 radial toolslides

[1] Correspondence with Mr. Petree should be addressed to 36 Mayfield Road, Sutton, Surrey, England.

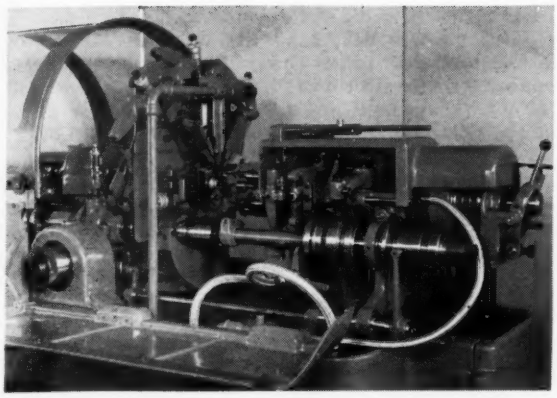


Fig. 3 BR-20 Automatic-turret lathe with sliding headstock. Back of machine, with guards removed.

respectively. The standard model has five radial toolslides and six more tools in the drum turret, headstock advance by means of one or two plate cams, and quick-acting drive to the camshaft to reduce idle time. Additional equipment is available for screwhead slotting, back counterboring, cross drilling, taper turning, etc., and, as an alternative, the machine can be supplied with a cam and lever attachment to advance the headstock.

The six toolholders in the turret are rotated by hardened and ground precision gearing which can be interchanged to give the best speed for the intended work, and in each holder it is possible to use, at choice, stationary spindles for centering, drilling, reaming, chamfering or deburring, revolving spindles for drilling or reaming, or threading spindles for right-hand or left-hand threading or tapping at overlapping speeds. Up to six revolving spindles or up to four threading spindles can be set up together. The turret is indexed hydraulically under the control of adjustable trip dogs, mounted on a drum on the camshaft, which actuate the valve of a hydraulic cylinder. A gear pump maintains the oil pressure. The operation of the indexing mechanism is independent of the camshaft speed, and, as the indexing locking plate is larger in diameter than the pitch circle of the turret spindles, it is claimed that an accuracy can be sustained in use which is superior to that of any other turret system.

Rolling Gear Testers

INCREASINGLY stringent requirements for the accuracy of small gear trains, particularly for radar and similar control systems in which backlash must be reduced to the minimum, have led to the introduction by J. Goulder & Sons, Limited, Kirkheaton, Huddersfield, England, of a rolling gear tester which will indicate a variation as small as 0.00003 in. in the distance between centers of a pair of gear wheels. The method adopted is the so-called "double-flank test" in which the gear under test is rolled against a master gear, the two being held together by spring pressure.

The No. 1 size, illustrated in Fig. 4, is a bench-mounted instrument suitable for gears of 20 to 100 diametral pitch and 4 in. center distance, or 5 in. pitch circle diameter when meshed with a master gear of 3 in. p.c.d. The floating and sliding saddles, which are made of nitriding steel, are superimposed, the floating saddle being supported on hardened ball tracks. The instrument may be fitted, at the purchaser's option, with either a microindicator made by the Société Genevoise d'Instruments de Physique or with a Taylor, Taylor & Hobson electrical inkless recorder, which has a range of magnifications between 100 and 5000 diameters. The work holder can be adjusted vertically to bring the test gear into the plane of the master gear without the use of packing, and the pressure of the spring which keeps the gears in contact can be varied between 4 oz and 32 oz. The upper or floating saddle can be locked to the lower saddle at about the mid-point of its "float" and the locking can be repeated within an accuracy of 0.00002 in.

For checking purposes, the equipment includes a pair of disks, one of which is truly concentric and the other eccentric by a calibrated amount; rolling these two disks together is equivalent to rolling two pitch circles on each other, and when the high point of the eccentric disk is in contact with the concentric disk the vernier scale should read the amount of the eccentricity, which is engraved

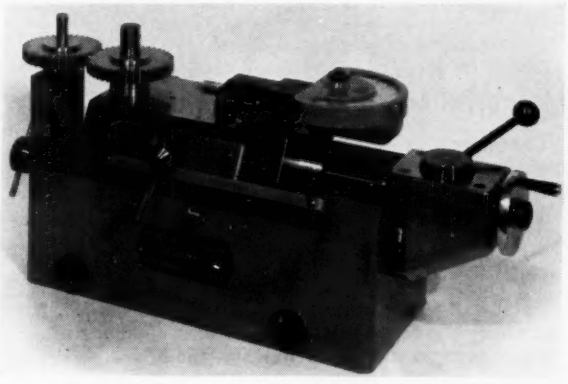


Fig. 4 No. 1 Rolling gear tester suitable for gears of 20 to 150 diametral pitch and 4-in. center distance

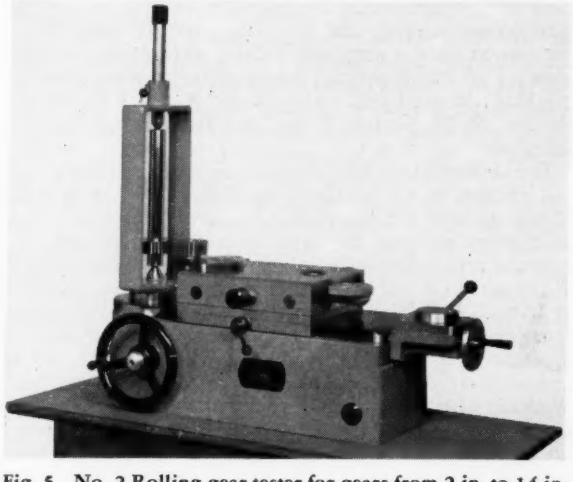


Fig. 5 No. 2 Rolling gear tester for gears from 2 in. to 14 in p.c.d. and weighing up to 25 lb each

on the disk. Attachments are also supplied to enable the instrument to be used for testing very small gears, shaft gears and bevel gears, and worms, either mounted between centers or in bushes.

A larger instrument, the No. 2 size, shown in Fig. 5, has been designed on the same principles for use by makers of gears for the automobile, aircraft, and machine-tool industries. It will accommodate gears from 2 in. to 14 in. p.c.d. and weighing up to 25 lb each. In this case the work holder is a hollow quill which can be adjusted vertically; it is 3 in. diam inside and 16 in. long and is adjustable over 7 in. by means of a rack and pinion. The top is closed by a removable bush in which arbors can be mounted, and the bottom by a bush which carries the long lower center. The quill can be locked at any point in its travel. The floating saddle can be locked in the same way as that of the No. 1 instrument, repeating to within 0.00005 in., and the spring pressure is adjustable between 8 oz and 4 lb, which is suitable for gears between 80 and 4 diametral pitch. The range of special attachments is similar to that for the No. 1 instrument. Both sizes are provided with means for withdrawing the saddle assembly quickly, so that the test gears, of whatever type, can be taken out of mesh without constant resetting of the indicator scale.

Memorial to James Rumsey

On September 6, 1784, George Washington wrote in his diary that he "Remained at Bath all day and was shown the model of a boat constructed by the ingenious Mr. Rumsey for ascending rapid currents by mechanism." The "mechanism" was a system of mechanically actuated poles and nothing much came of it, but three years later James Rumsey developed a method of propelling a boat by a water jet which was much more promising. To promote it the Rumseian Society was formed, with Benjamin Franklin as one of its supporters, and with this backing Rumsey visited England, where he tried a steamboat of his design on the river Thames; but on December 23, 1792, while lecturing on the subject of steam navigation to the Royal Society of Arts, he suddenly collapsed and died. He was buried in the churchyard of St. Margaret's, Westminster, in the shadow of Westminster Abbey; and in that church, on May 18 of the present year, a memorial to him was unveiled in the presence of the American Ambassador, His Excellency the Hon. Winthrop W. Aldrich, by Admiral the Hon. Sir Guy H. E. Russell, Second Sea Lord in the British Admiralty.

The memorial to Mr. Rumsey is a restoration of a lost epitaph by the English poet Robert Herrick (1591–1674), written for his niece, Elizabeth Herrick. The inscription beneath it states that "This epitaph by Robert Herrick, formerly on a mural tablet in the middle of the north aisle of this church, was restored in memory of JAMES RUMSEY, whom the State of West Virginia honours as the inventor of the Steamboat, which he demonstrated privately to George Washington in 1784 and publicly on the Potomac River at Shepherdstown, W. Va., 3 December, 1787. Born of English parents in Cecil County, Maryland, in 1783, he died while lecturing on the principles of steam navigation to English scientists in London, and was buried in Sr. Margaret's Churchyard, 24 December, 1792."

The service of dedication, which included an address by Prof. Basil Willey, King Edward VII Professor of English Literature in the University of Cambridge, was conducted by the Rector of St. Margaret's, the Reverend Canon Charles Smyth, M.A., who was formerly a lecturer in history at Harvard University, Cambridge, Mass.

International Internal-Combustion-Engine Congress

The first meeting of the International Internal-Combustion-Engine Congress was held in Paris in 1951 and the second in Milan in 1953. The third, in Holland, was officially opened on May 23, 1955, in the historic Ridderzaal, the "Hall of the Knights," at The Hague, the subsequent technical sessions and the concluding banquet on May 26 being held in the Kurhaus at Scheveningen.

It was well attended, there being rather more than 650 participants from 15 countries. The principal emphasis was on engines for rail traction, 14 of the 28 papers being devoted to them; these formed Group A in the program. Group C, containing ten papers, was entitled "Marine and Stationary Purposes" but, in fact, was concerned almost entirely with marine engines, more especially those of more than 10,000 hp. Group B, in the English version of the program, was headed "General," but the French program's title of "Généralités" described it more accurately, one of its four papers (French) dealing, in separate sections, with fuel and lubricating oils, one (English) with engine noise, one (Swiss) with exhaust scavenging impulses as a means of increasing the output of four-stroke engines, and the fourth, by Prof. C. Fayette Taylor of M.I.T., with the relation of cylinder size to the design and performance of engines for railway and marine service.

An excellent comparative survey in Group A, by M. Tourneur, chief engineer of the French Railways, of "The Evolution of Diesel Railway Traction Engines," drew attention to their remarkable progress in the United States, noting that whereas, in 1939, the Class I railroads had only 500 diesel units among their 30,000 locomotives, by the end of 1954 they had 23,000. He commented also on the rather curious fact that all the European engines specially constructed for rail traction were of the four-stroke type, but United States practice showed a preponderance of two-stroke engines. Much attention was given in both Groups A and C to supercharging, but there was some difference of opinion—indeed, a direct conflict of statements—regarding the possibility of running a stationary exhaust turboblower up to approaching working speed by the initial blast of starting air applied to the engine. A further diversity of opinion appeared in the matter of the number of turboblowers required for optimum operation of multicylinder marine engines.

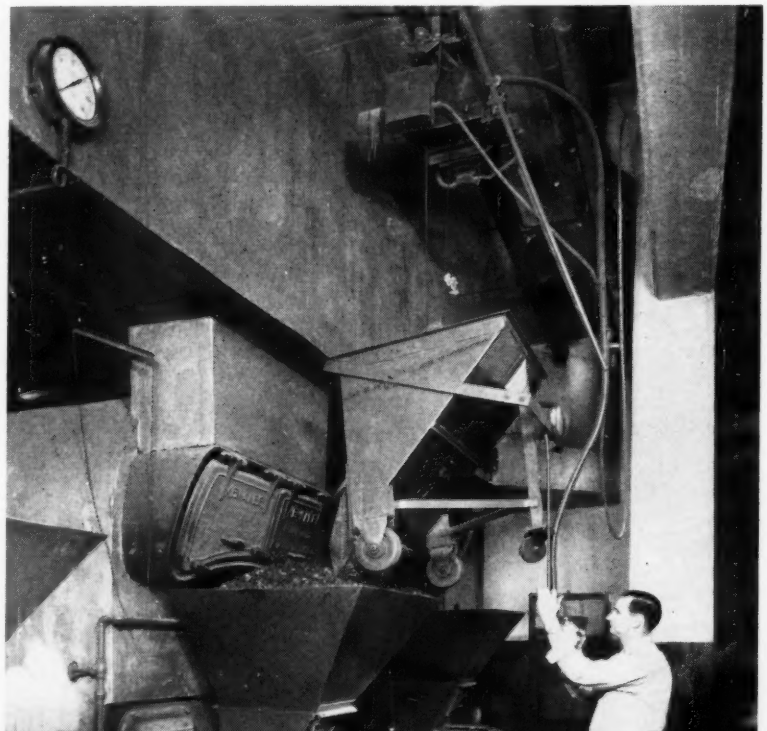
It was somewhat unfortunate that the manner of conducting the discussions—which took the form of replies by the authors to questions previously submitted in writing and merely introduced by the questioners in the meetings—did not permit of the kind of "free-for-all" arguments which are such a feature of most British and American technical sessions and which might have enabled some of these debatable points to be thrashed out more fully.

Substance in Brief of Papers Presented at ASME Meetings

Fuels Technology

Coal and Ash-Handling Problems in Small Plants, by D. M. Given, Mem. ASME, and C. A. Marshall, Mem. ASME, Fairmont Coal Bureau, New York, N. Y. 1955 ASME Semi-Annual Meeting paper No. **55—SA-47** (multilithographed; available to April 1, 1956).

THE demand for greater mechanization of small boiler plants has substantially raised the performance standards for coal and ash-handling systems in the past few years. As a result, much attention is being focused on the limitations of existing installations and how they might be modified to provide more acceptable performance. Designers of new plants are likewise finding it necessary to take a greater interest in such factors as eliminating dust and providing higher dependability of handling equipment. The need to control capital investment in relation to the size of plant involved imposes some restrictions on the types of equipment which may be considered but, in effect, helps to simplify the problem of selecting a satisfactory design.



Monorail hoist and bucket installation for $500 to $800 coal-handling system

This paper covers some of the more important design considerations for plants ranging in size from 200 to 30,000 tons of annual coal consumption. Corresponding steam loads range as high as 150,000 lb per hr whereas the smallest plants considered are those used for low-pressure heating in schools and apartment houses. All have one thing in common. They can be adequately mechanized for one-man operation assuming, of course, that another man is available for unloading cars in cases where the coal is received by rail.

Various problems are discussed which can affect adversely the performance of coal and ash-handling systems in small plants. Suggestions are made for minimizing such problems and at the same time controlling operating and investment costs to acceptable levels.

Flame Geometry as a Factor in Industrial Heat Processing, by R. C. LeMay, Mem. ASME, Selas Corporation of America, Philadelphia, Pa. 1955 ASME Semi-Annual Meeting paper No. **55—SA-10** (multilithographed; available to April 1, 1956).

MODERN methods for controlling, accelerating, and stabilizing combustion have made possible the determination of flame geometry to an extent which permits use of this device as a valuable tool for industry. Traditionally, flames have been maintained within enclosures or against surfaces being heated under conditions where quantity of heat release, flame retention, and fuel-air ratio are the only considerations. Most types and quantities of fuels are still burned under such conditions.

Recent emphasis given to "automation" by industry is the current expression of a long-established and accelerating trend toward bringing heretofore remote processes into primary production lines. That this integration increases the need for precision control over heat application is readily apparent. Additionally, the requirement that production lines be held to reasonable length necessitates design and selection of heat processes which require the minimum of time and space. Because many heat-treating operations can be most rapidly

Needle or spear flames shown fusing glass to metal parts of TV picture tubes

and satisfactorily performed with high thermal heads when adequate control is possible, flame geometry therefore assumes major importance. Further, it is of maximum importance to the goodly number of operations in which heat must be confined to a small and equal section of each successive part.

In varying degrees, control of flame geometry has been employed to increase the usefulness of all fuels, and it is believed that more precise control will further increase the usefulness of each. To date, however, it is the gas-fired processes which have most extensively and effectively utilized the deliberately shaped flame. This paper is confined to discussing such applications of gaseous fuels.

Optimum use of flame geometry requires separate and adequate control of each of the following factors: (1) Fuel composition, (2) fuel-air ratio, (3) fuel-air mixture pressure at the burner, (4) burner design, (5) draft conditions, (6) workpiece placement in relation to the burner, and (7) duration of exposure. Control of the first five factors is required for flame stability alone, whereas satisfactory production-line heating may well demand close supervision of all seven.

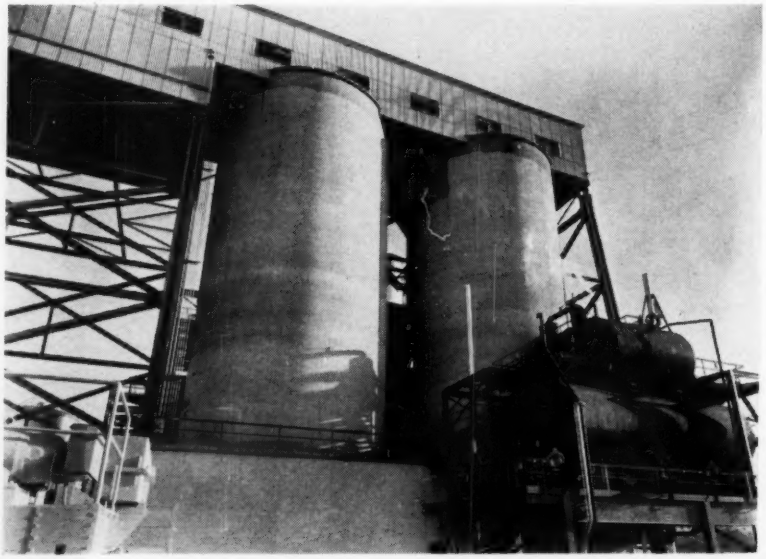
After a discussion of factors over which high-thermal-head heat processing requires effective control, the paper presents representative successful applications. The following general burner types have been employed for the purpose: (1) The "ribbon" burner; (2) the "spear flame" or "needle" burner; (3) the round screen burner; (4) the radiant ceramic burner; and (5) the enclosed combustion burner.

Coal and Ash Handling, Martins Creek Steam Electric Station, by W. H. Kopenhaver, Pennsylvania Power & Light Company, Martins Creek, Pa. 1955 ASME Semi-Annual Meeting paper No. **55—SA-46** (multilithographed; available to April 1, 1956).

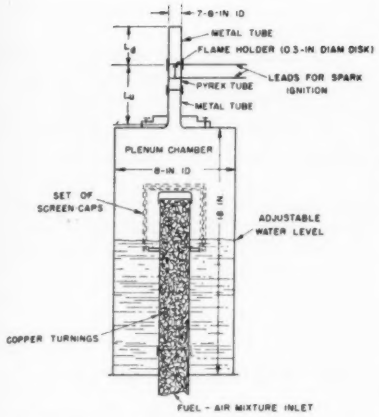
ON Oct. 1, 1954, Martins Creek Steam Electric Station, Pennsylvania Power and Light Company's first semioutdoor plant, was placed in operation. The plant is fired with 100 per cent pulverized bituminous coal and is designed for low-load-factor operation. The outdoor-type plant is new to the industry in the northeastern United States. This paper presents a general description of the plant and its operation and deals specifically with bituminous coal handling, pulverizing, burning, and ash handling. Some operating problems and their solutions are discussed. Reference is made to a duplicate second unit presently under construction scheduled to be placed in operation during the summer of 1956.

Low-Frequency Oscillations in a Flame-Filled Tube, by A. A. Putnam, Mem. ASME, and W. R. Dennis, Battelle Memorial Institute, Columbus, Ohio. 1955 ASME Semi-Annual Meeting paper No. **55—SA-48** (multilithographed; available to April 1, 1956).

FLAME-DRIVEN oscillations were observed in a small combustion tube attached to a plenum chamber. Two distinct types of oscillation were generated, depending on the distance between the flameholder and the exit of the tube. With the flameholder near the exit, the frequencies corresponded to the calculated frequencies for the first and higher modes of the tube alone; these oscillations were discussed in an earlier



View showing two 1200-ton-capacity (each) coal silos of 135,000-kw Martins Creek Steam Electric Station of the Pennsylvania Power and Light Company



Combustion tube and plenum chamber used in the experimental investigation. The combustion tube consists of a stainless-steel upstream section, a Pyrex flameholder section, and a stainless-steel combustion section.

paper. As the flameholder was moved farther into the tube (in the vicinity of the middle), the natural frequency oscillations were supplanted by a low-frequency oscillation, which is the subject of this paper. The oscillation described had a frequency lower than the fundamental frequency of the tube considered separate from the plenum chamber, but higher than the Helmholtz frequency of the system including both tube and plenum chamber. The oscillation was accompanied by large-scale changes in the size and shape of the flame during each cycle.

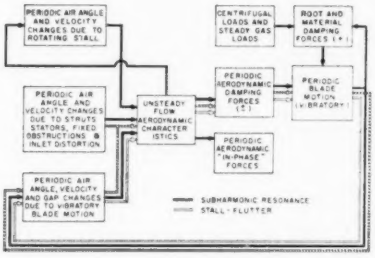
A theory for the generation of the oscillations is proposed in which the large-scale flame movements are considered to be the source of the driving. The proposed mechanism requires that there be one pressure node between the entrance of the combustion tube at the plenum end and the flameholder; the existence of this node was verified by experiment. The theory predicts the characteristics of the oscillation with various changes in the physical parameters of the system and, in particular, accounts for the observed low frequency.

Aviation

A Survey of Aerodynamic Excitation Problems in Turbomachines, by A. Sabatiuk and F. Sisto, Curtiss-Wright Corporation, Woodridge, N. J. 1955 ASME Semi-Annual Meeting paper No. **55—SA-40** (multilithographed; to be published in Trans. ASME; available to April 1, 1956).

During the past decade a considerable body of literature has come into existence concerning the aeroelastic problems of turbomachine blading. As with the airplane wing problem, this growing attention has been demanded by industrial problems of the first magnitude.

Aerodynamic excitation phenomena can decrease aerodynamic performance and penalize seriously the useful life of turboblades. Exceptionally high vibratory stresses may be obtained which, in turn, cause blade failures through fatigue. A thorough understanding of the excitation mechanism is required before these dangerous conditions can be eliminated.


PERIODIC AIR ANGLE AND VELOCITY CHANGES DUE TO ROTATING STALL
CENTRIFUGAL LOADS AND STEADY GAS LOADS
ROOT AND MATERIAL DAMPING FORCES (+)
PERIODIC AERODYNAMIC DAMPING FORCES (-)
PERIODIC BLADE MOTION (VIBRATORY)
PERIODIC AIR ANGLE AND VELOCITY CHANGES DUE TO STRUTS STATORS, FIXED OBSTRUCTIONS & INLET DISTORTION
UNSTEADY FLOW AERODYNAMIC CHARACTERISTICS
PERIODIC AERODYNAMIC "IN-PHASE" FORCES
PERIODIC AIR ANGLE, VELOCITY AND GAP CHANGES DUE TO VIBRATORY BLADE MOTION
SUBHARMONIC RESONANCE
STALL-FLUTTER

Schematic diagram of aerodynamically excited blade-vibration phenomena

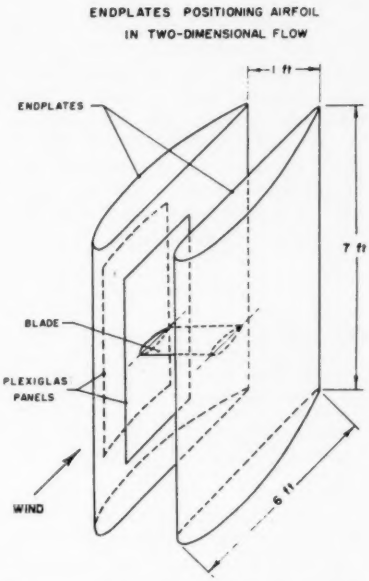
The important blade-excitation phenomena in turbomachines are reviewed with respect to the theory extant in the literature and with respect to typical experimental results. The mechanisms of flutter, forced excitation, and rotating stall are discussed broadly and the importance of subharmonic resonance in turbine blades is introduced.

Finally, general topics worthy of further consideration are enumerated and avenues for future research are delineated.

A Practical Approach to the Problem of Stall Flutter, by Chi-Teh Wang, R. J. Vaccaro, and D. F. De Santo, New York University, New York, N. Y. 1955 ASME Semi-Annual Meeting paper No. **55—SA-69** (multilithographed; available to April 1, 1956).

Since the inception of axial-flow aircraft gas turbines the fatigue and eventual failure of compressor blades has been of considerable concern to blade designers. It is generally conceded that nearly all blade vibration is of aerodynamic origin and is usually associated with stall flows. A program has been initiated at the Guggenheim School of Aeronautics of New York University to study the stall flutter of blade systems. As a first step, the problem of stall flutter of a single blade or airfoil has been studied briefly.

A method is presented in this paper whereby the real part of the dynamic moment coefficient may be obtained from a flutter test on a single blade oscillating in torsion alone in the stall region. These data may be used to predict the critical flutter velocity and frequency of a blade with the same geometrical properties oscillating with two degrees of freedom and having arbitrary elastic and inertial properties. It is possible that the present method can be used to predict the flutter speed and frequency of a cantilever blade by either a representative section or a Rayleigh-type analysis.



Flutter experiments carried out in the 7 × 10-ft wind tunnel at the Guggenheim School of Aeronautics. A single airfoil is positioned between two large wings or "endplates" which are spaced 1 ft apart and span the wind-tunnel test section from floor to ceiling, thus furnishing a two-dimensional airstream. To permit observation, one endplate is equipped with plastic windows on both the exterior and the interior sides.

The Flow in a Vee-Gutter Cascade, by W. G. Cornell, Mem. ASME, General Electric Company, Cincinnati, Ohio. 1955 ASME Semi-Annual Meeting paper No. **55—SA-58** (multilithographed; to be published in Trans. ASME; available to April 1, 1956).

In afterburners of modern aircraft gas-turbine power plants and in other combustion systems, various bluff bodies are used for flameholders, creating low-velocity regions downstream in order to stabilize combustion. One of the most frequently used configurations is the vee-gutter flameholder, composed of concen-

tric annular rings of vee cross section with apex upstream. In the design of vee-gutter flameholders, a method is needed to predict the effect of vee-gutter geometry on aerodynamic forces on the gutters, total pressure loss, and wake shape.

A theory is presented, yielding the wake shape, the total pressure loss, and the drag force of two-dimensional vee-gutter profiles in unstaggered cascade array, for incompressible, steady, potential flow directed normal to the cascade axis. The results, for all gutter-included angle and blockage ratio, are compared to two and three-dimensional experimental results, showing good agreement. Approximate theories are presented, valid at high blockage ratio and either at small or large gutter angle.

Determination of Mach Number From Pressure Measurements, by F. W. Barry, Assoc. Mem. ASME, United Aircraft Corporation, East Hartford, Conn. 1955 ASME Semi-Annual Meeting paper No. **55—SA-28** (multilithographed; to be published in Trans. ASME; available to April 1, 1956).

The relative newness of the study of supersonic flows, coupled with the large increases in the number of supersonic wind tunnels and the operation of missiles at supersonic speeds, emphasizes the need for a periodic evaluation of the instruments and techniques used for measuring these flows.

Of the various compressible-flow parameters which one may wish to determine experimentally, Mach number is nearly always the most important. The fact that a calibration of a supersonic wind tunnel is largely a matter of determining the Mach number distribution in the test section attests to the significance of this parameter.

This paper contains a discussion of the errors introduced by using various combinations of measured pressures to compute Mach number, especially in supersonic flow. Pressures measured with total, static, conical, and two-dimensional wedge probes are considered.

A procedure is developed for estimating the effect on computed Mach number of errors in the measured pressures, or in the assumed values of the ratio of specific heats and of probe-deflection angle.

Results of the error analysis for 10 pressure-ratio combinations from total, static, and wedge probes are presented analytically and in graphical form. In general, a Mach number computed from a pressure ratio involving the isentropic stagnation pressure is least sensitive to errors, and one computed from the ratio of static pressure on the wedge surface to free-stream static pressure is most sensitive.

A brief review of some other considerations in choosing pressure instrumentation is included.

Fluid Meters

Survey of Mass-Rate Flow-Measuring Principles by Y. T. Li and S. Y. Lee, Massachusetts Institute of Technology, Cambridge, Mass. 1955 ASME Semi-Annual Meeting paper No. **55—SA-72** (multilithographed; available to April 1, 1956).

In this paper, various mass-rate flow-measuring meters are classified according to their operating principles. The respective merits of the operating principles are discussed as well as their accuracy and suitability for differing flow conditions. Of particular interest are the recently developed transverse-momentum meters that perform with high accuracy under a wide range of operating conditions.

The principal drawback of a transverse-momentum flowmeter is the mechanical complexity of moving parts, rotary seals, and a constant-speed drive. On the other hand, the performance of a transverse-momentum flowmeter of a suitable design is almost unsurpassed by flowmeters of other known types.

The chief merits of a well-designed mass-rate flowmeter based upon transverse-momentum principles are:

1 Capability of measuring fluid with wide variation of physical properties.

2 Capability of measuring liquid with wide range of flow rate.

3 Capability of handling nonhomogeneous fluids and also pulsating flows.

4 Linear output.

5 Field calibration unnecessary. The output of a well-designed meter of this type is almost identical to the theoretical figures based on the design parameters.

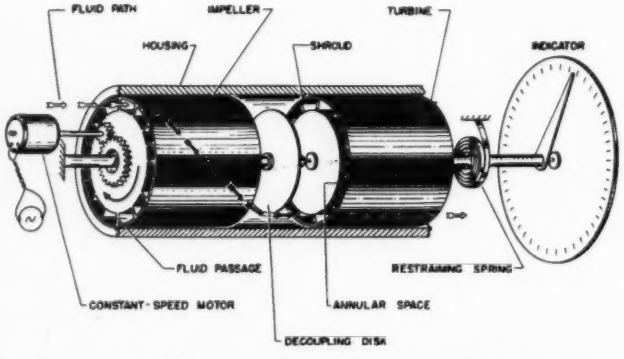
Among the transverse-momentum flowmeters, the radial-flow type seems to lead in general performances. The axial flowmeter and the gyroscopic meter would be best suited for homogeneous liquids with relatively small viscosity variations.

Gas Turbine Power

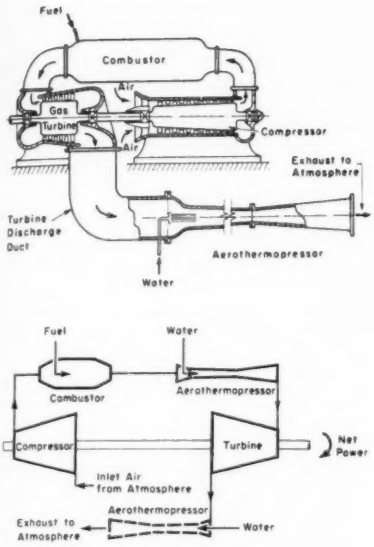
The Aerothermopressor—A Device for Improving the Performance of a Gas-Turbine Power Plant, by A. M. Shapiro, Mem. ASME, K. R. Wadleigh, Mem. ASME, B. D. Gavril, Assoc. Mem. ASME, and A. A. Fowle, Massachusetts Institute of Technology, Cambridge, Mass. 1955 ASME Semi-Annual Meeting paper No. **55—SA-65** (multilithographed; to be published in Trans. ASME; available to April 1, 1956).

This paper presents both an introduction and a progress report on an aerothermodynamic device which performs the function of a compressor but which requires only an extremely simple mechanical structure having no moving parts. Basically, the Aerothermopressor is a duct within which atomized water evaporates into a high-speed stream of high-temperature gas, thereby inducing a rise in isentropic stagnation pressure of the gas stream. One of the best applications of the Aerothermopressor is as an auxiliary for improving the performance of a gas-turbine plant.

The paper (1) develops the basic ideas



Axial-flow-type transverse-momentum flowmeter. The unit consists of two similar cylinders placed end to end so that the two axes coincide. The instrument housing closely fits the outer diameter of the cylinders. Around the periphery of the cylinders are located a number of passages, the axes of which are parallel to the axes of the cylinder. Fluid moving through the pipe line enters the passages in the first cylinder, proceeds through the passages in the second cylinder, and continues along the pipe line. (Reproduced by courtesy of the Aircraft Instrument Engineering Division of the General Electric Company.)



Application of the Aerothermopressor to the simple gas turbine. *Top*, at exit of turbine; *bottom*, between burner and turbine.

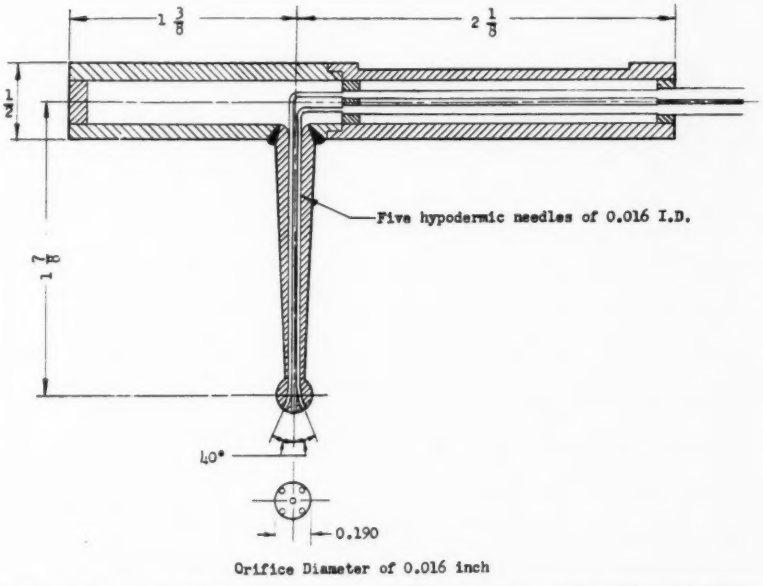
and the theory of the Aerothermopressor, (2) illustrates its application to the gas-turbine plant, (3) discusses the factors entering into the design of an Aerothermopressor and the considerations for handling them, (4) presents the theoretical and experimental results thus far obtained, and (5) evaluates the future prospects of the Aerothermopressor and names the crucial problems which it faces.

The Combustion of Liquid Fuel Spray, by Jax A. Bolt, Mem. ASME, and Thomas A. Boyle, Assoc. Mem. ASME, University of Michigan, Ann Arbor, Mich. 1955 ASME Semi-Annual Meeting paper No. **55—SA-67** (multilithographed; to be published in Trans. ASME; available to April 1, 1956).

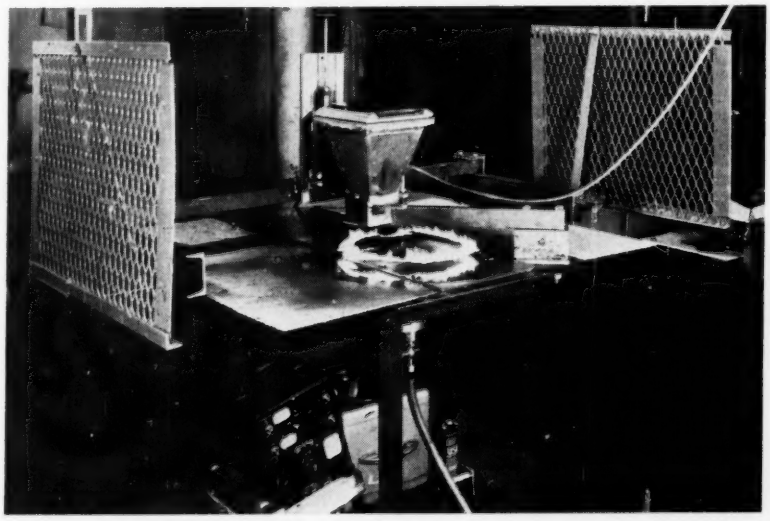
THIS paper is concerned with the evaporation and combustion of liquid fuel spray in the range of sizes predominantly used in aircraft gas-turbine combustors. Spray of uniform size fuel drops of 70 to 130 microns diam was produced by means of a spinning disk. Photographic techniques were developed to obtain an indication of the rate of change of diameter and the velocity of the burning drops, while moving freely in air. Rates of burning for several pure hydrocarbon fuels were determined. The experimental work accomplished emphasizes the complexity of the combustion of a fuel spray, and the need for much additional work.

A Three-Dimensional Spherical Pitot Probe, by James E. Ash, Assoc. Mem. ASME, and John C. Lee, Armour Research Foundation, Chicago, Ill. 1955 ASME Semi-Annual Meeting paper No. **55—SA-56** (multilithographed; to be published in Trans. ASME; available to April 1, 1956).

THE conventional method of applying the five-hole spherical pitot probe to three-dimensional flow measurements consists of either adjusting the probe until its axis points in the flow direction, or yawing the probe until the meridian plane passing through the center orifice contains the flow angle, and then making



Five-hole spherical pitot probe with a head diameter of 0.190 in. which calibrates three-dimensionally to measure static pressure, velocity, and flow direction in the rotating cascades. It consists essentially of a tapered shaft with a 0.190-in. diam spherical sensing-head at the end. The other end of the shaft is welded at a right angle to a crosspiece which is to be mounted between the two shrouds of the blade cascade during tests.



Test stand with burning fuel spray. For determining velocities, two photolights were used. These supplied light to a half-silvered mirror and then through the spray to the camera. The second photolight was fired at a known interval after the first so that knowledge of the distance between the two images of a drop would permit determining its velocity.

use of two-dimensional calibration curves for the flow determination in this plane. Both methods require adjustment of the probe, which, in general, is quite difficult to accomplish if the probe is mounted upon a rotating impeller. To avoid this difficulty, a five-hole, three-dimensional spherical pitot probe has been developed and calibrated to measure static pressure and the magnitude and direction of the velocity vector, for any arbitrary flow angle without adjustment of the probe.

Some Aerodynamic Investigations in Centrifugal Impellers, by J. T. Hamrick, National Advisory Committee for Aeronautics, Lewis Flight Propulsion Laboratory, Cleveland, Ohio. 1955 ASME Semi-Annual Meeting paper No. **55—SA-53** (multilithographed; to be published in Trans. ASME; available to April 1, 1956).

RESULTS of both theoretical and experimental investigations of flow in rotating impeller passages are presented. The purpose of this paper is to acquaint the designer with the manner in which losses arise, their effect upon the flow within the passage, and their over-all effect upon impeller performance. In addition, analysis and design methods based on isentropic flow calculations are discussed and their application to the design of mixed-flow impellers is demonstrated.

Heat Transfer

Local and Average Coefficients of Heat Transfer for Horizontal Laminar Motion of Fluids in a Circular Tube, by Charley Scott, Assoc. Mem. ASME, Mississippi State College, State College, Miss., Glen E. Eggleston, Assoc. Mem. ASME, Douglas Aircraft Company, Santa Monica, Calif., and W. L. Sibbitt, Assoc. Mem. ASME, Purdue University, West Lafayette, Ind. 1955 ASME Semi-Annual Meeting paper No. **55—SA-17** (multilithographed; available to April 1, 1956).

LOCAL and average coefficients of heat transfer have been investigated experimentally for water, transformer oil, and a "viscosity-increased" water solution flowing in laminar motion through a circular tube with wall at constant temperature. Simultaneous development and separate development of the thermal and hydrodynamic boundary layers were investigated. The Reynolds modulus ranged from 76 to 1756; Graetz modulus, from 9.5 to 170,000. The investigation of 24 ratios of L/C from 0.782 to 148 was possible with the equipment. The data have been correlated with an adaption of the Hausen approximation to the Graetz second solution for tubes with calming sections. An attempt has been made to explain the deviations caused by free convection and changes in the velocity distribution due to the change of temperature by the use of a Grashof group. The viscosity-increased water produced results that were from 0.2 to 0.5 of the theoretical value.

Response of Temperature-Measuring Elements to Thermal Transients, by J. A. Clark, Assoc. Mem. ASME, Massachusetts Institute of Technology, Cambridge, Mass. 1955 ASME Semi-Annual Meeting paper No. **55—SA-18** (multilithographed; available to April 1, 1956).

THE requirements of modern automatic control and regulation demand increased speed of response from all measuring instruments. Not least among these various instruments are those which measure and record temperature—or some property whose change under certain specified and controlled conditions is related to temperature. During any temperature change—the transient period—it clearly is important to have accurate and timely information from those instruments sensing and controlling temperature. The paper reviews and summarizes what has previously been published on this subject, presents new information and, in some instances, amplifies the old. Throughout, an emphasis has been placed upon engineering utility of the results.

Heat Transfer to Laminar Flow in a Round Tube or Flat Conduit—The Graetz Problem Extended, by J. Sellars, University of Michigan, Ann Arbor, Mich., M. Tribus, Mem. ASME, University of California, Los Angeles, Calif., J. Klein, Oberlin College, Oberlin, Ohio. 1955 ASME Semi-Annual Meeting paper No. **55—SA-66** (multilithographed; to be published in Trans. ASME; available to April 1, 1956).

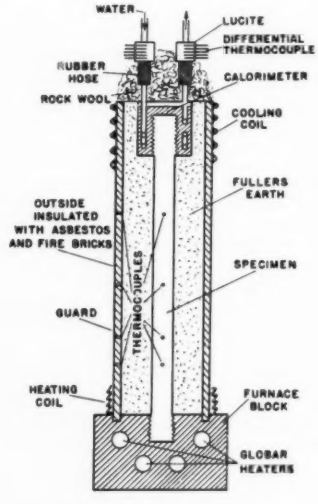
THE problem considered is posed by a system in which a fluid of constant properties flows in steady laminar motion in a round tube or flat duct. The velocity profile is fully established and parabolic. Up to a point ($x = 0$) the fluid is isothermal. After this point a prescribed heat flux or temperature is given at the wall of the conduit and the problem is to find the temperature distribution, as well as the connection between heat flux and wall temperature. The application of this solution to practical problems of heat exchange has been well established.

The problem has been considered in detail by a number of workers and an excellent review is contained in the book "Heat Transfer," by M. Jakob. The problem readily reduces to the finding of eigenvalues and prior to this paper only the first three eigenfunctions and the first four eigenvalues have been known. A recent paper has brought out the importance of obtaining more eigenvalues, and by using the complete set of eigenvalues and the methods referred to, the classical "Graetz problem" is extended to more complicated boundary conditions.

The methods used in this paper have a wide applicability. For example, the liquid metals systems analyzed by Poppendiek could be treated by the methods used here. The unsymmetrical boundary conditions treated by Yih and Cermak can also be readily treated by these methods.

Thermal Properties of Titanium Alloys and Selected Tool Materials, by E. G. Loewen, Mem. ASME, Massachusetts Institute of Technology, Cambridge, Mass. 1955 ASME Semi-Annual Meeting paper No. **55—SA-45** (multilithographed; to be published in Trans. ASME; available to April 1, 1956).

DURING recent theoretical investigations of cutting-tool temperatures it became evident that there was insufficient data available on the thermal conductivity and specific heat at elevated temperatures of many important materials, especially titanium alloys. Using fairly conven-



Sketch of thermal conductivity apparatus. Thermal conductivity was found from the measurement of the temperature gradient in a $^3/_4$-in-diam rod, one end of which was heated and the other end cooled by a constant flow calorimeter. A guard tube was used to approach one-dimensional heat flow as closely as possible.

tional methods the thermal conductivities of five titanium alloys, four high-speed steels, and four types of carbide tool materials were measured up to 1000 F. In addition, the specific heat of two titanium alloys was determined over a range of 70 to 1400 F.

Average and Local Heat Transfer for Crossflow Through a Tube Bank, by R. A. DeBortoli, R. E. Grimble, and J. E. Zerbe, Assoc. Mem. ASME, Westinghouse Electric Corporation, Pittsburgh, Pa. 1955 ASME Semi-Annual Meeting paper No. **55—SA-51** (multilithographed; available to April 1, 1956).

HEAT-TRANSFER coefficients have been determined for a crossflow tube bank by the use of heat and mass-transfer techniques for the Reynolds number range of 35,000 to 80,000. The average heat-transfer coefficients agree favorably with extrapolations of existing data. The local coefficient variations from the average were as great as +80 per cent and −55 per cent.

Heat Transfer to Turbulent Boundary Layers With Variable Free-Stream Velocity, by R. A. Seban, Mem. ASME, University of California, Berkeley, Calif., and D. L. Doughty, Assoc. Mem. ASME, Shell Development Company, Emeryville, Calif. 1955 ASME Semi-Annual Meeting paper No. **55—SA-68** (multilithographed; to be published in Trans. ASME; available to April 1, 1956).

LOCAL heat-transfer coefficients have been determined for the turbulent boundary layer of a two-dimensional, subsonic air flow over the surface of a flat plate, with the air velocity variable over the plate length. The boundary layer, formed with almost constant velocity, was then subjected to a strong acceleration which produced a three to fourfold increase in the free-stream velocity, and after this maximum there was a gradual deceleration of the flow. Maximum velocities ranged from 200 to 900 fps. The use of the results, obtained for a particular kind of variation of velocity, is primarily as a check of methods of predicting heat transfer under circumstances of this type. It is shown that adequate predictions can be made from an analysis based on constant properties, and that the most important element of the analysis is an account of the thermal energy in the boundary layer at any point along the plate. Results are given also for constant velocity along the plate, both for a completely turbulent flow and for turbulent flow occurring after natural transition. The heat-transfer coefficients so obtained for the turbulent boundary layer agree best with the prediction of the von Karman analogy.

Laminar Free Convection From a Vertical Plate With Uniform Surface Heat Flux, by E. M. Sparrow, and J. L. Gregg, National Advisory Committee for Aeronautics, Lewis Flight Propulsion Laboratory, Cleveland, Ohio. 1955 ASME Semi-Annual Meeting paper No. **55—SA-4** (in type; to be published in Trans. ASME; available to April 1, 1956).

AN exact solution of the laminar boundary-layer equations for free convection from a vertical plate having uniform surface heat flux has been obtained. Heat-transfer parameters have been calculated for Prandtl numbers in the range 0.1 to 100. The results have been extrapolated to a Prandtl number of 0.01.

Experimental results are compared with the theory and the agreement is found to be good. Heat-transfer results obtained from the von Karman-Pohlhausen method also are shown to be in good agreement with those from the exact solution. It is demonstrated that when average Nusselt numbers are calculated for a plate with uniform surface heat flux using the temperature difference halfway along the height, the results are very close to those for a uniform temperature plate.

Matrix Analysis of Heat-Transfer Problems, by Louis A. Pipes, University of California, Los Angeles, Calif. 1955 ASME Semi-Annual Meeting paper No. **55—SA-34** (multilithographed; available to April 1, 1956).

THIS paper presents a method of analysis of heat-conduction problems in solids based on matrix algebra. Use is made of the analogy that exists between the thermal problem and the flow of electricity in an electrical transmission line. It is shown that the use of matrix algebra greatly facilitates the calculation of transient and periodic heat flow in composite solids.

On a Generalized Procedure for the Calculation of Thermal Radiation Transfer, by B. T. Chao, University of Illinois, Urbana, Ill. 1955 ASME Semi-Annual Meeting paper No. **55—SA-61** (multilithographed; available to April 1, 1956).

A SYSTEMATIC procedure is introduced for determining the radiant heat transfer between a radiating gas or flame and a gray receiving surface in a closed chamber consisting of n gray surfaces, all of different emissivities. The effect of radiating beam length on the absorptivity of the gas or flame is considered. The resulting equations are then modified for the calculation of radiant heat transfer between gray surfaces in an enclosure separated by nonabsorbing media. The solution and particularly the method presented have wider application than those heretofore published. For numerical calculation, the results can be obtained readily from the digital computer.

A New Electrical Analog Method for the Solution of Transient Heat-Conduction Problems, by G. Liebmann, Associated Electrical Industries, Ltd., Berkshire, England. 1955 ASME Semi-Annual Meeting paper No. **55—SA-15** (multilithographed; to be published in Trans. ASME; available to April 1, 1956).

A NEW resistance-network analog method for the solution of heat-flow problems under transient conditions is described. In this method, electrical networks represent the difference equations which approximate the differential equations governing the problem to be solved. Temperature is represented by voltage, the spatial features of the problem by a network of parallel resistances, and the thermal constants by series resistances. A solution in steps δt of time is obtained by successive readjustments of potentiometers supplying the voltages to the network. The new method is very flexible, the time interval δt and the thermal constants being adjustable during the progress of the work. It can be applied to problems of considerable complexity. One of its outstanding features is its "stability." Accuracies of better than 1 per cent can be obtained.

Hydraulics

A Comparison of Regenerative Pump Theories Supported by New Performance Data, by Yasutoshi Senoo, Research Institute for Applied Mechanics, Kyushu University, Fukuoka, Japan. 1955 ASME Semi-Annual Meeting paper No. **55—SA-44** (multilithographed; available to April 1, 1956).

SEVERAL theories of the fluid-dynamic mechanism of a regenerative pump have been presented. The author compares these theories and makes clear the similar and different points among them. In his opinion, the performance of a regenerative pump is influenced by many factors, and one assumption is useful for a certain limited condition but another assumption may be preferable for another condition. He presents a series of experimental data concerning the geometry of the pumping channel. Although the influence of the geometry of the pumping channel on the performance is really com-

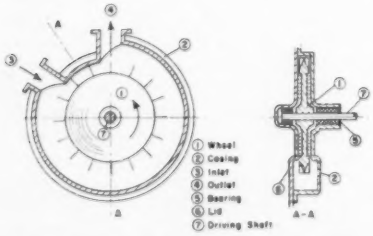
plicated, consistent tendencies are found for the influence within the experimental range. These tendencies and experimental data are available not only as an aid to design but also may serve as a guide for the improvement of any simple semiempirical theory of the regenerative pump as well as for testing any complete theories.

Streamlined Pitot-Tube Bar for Measuring Water Flow in Large Pipes, by F. Numachi, H. Murai, and S. Abe, Institute of High Speed Mechanics, Tohoku University, Sendai, Japan. 1955 ASME Semi-Annual Meeting paper No. **55—SA-25** (multilithographed; to be published in Trans. ASME; available to April 1, 1956).

With the aim of measuring flow through pipes of large diameter, a "streamlined pitot-tube bar" was devised. Basic studies, both theoretical and experimental, were carried out in a preliminary way on the cross-sectional form of the bar in order to obtain the best results. Based on the sectional form finally selected, a full-size model was prepared and tested, from which the pitot coefficient and other pertinent data were obtained. Two actual pitot-tube bars of 60-mm chord and 2.000-m length were constructed and used in measuring the flow in the main pipe of the pump installed at the Numazawanuma storage system hydroelectric station.

Analysis of Traction Pumps, by F. S. Weinig, Mem. ASME, General Electric Company, Cincinnati, Ohio. 1955 ASME Semi-Annual Meeting paper No. **55—SA-35** (multilithographed; available to April 1, 1956).

For relatively small delivery volume and relatively high delivery head, the traction pump seems to be quite suitable especially when cavitation is threatening and when the angular speed of the engine is high. The traction pumps have the disadvantage that the efficiency is relatively low. The analysis shows the limits of performance and efficiency as well as means to optimize them.



Principal design of a traction pump

The analysis of the traction pump shows that the losses can be divided into slip, disk friction, casing friction, leakage, and exchange losses. The slip losses represent the main losses and are inherent to the working principle of the traction pump. The other losses can be kept reasonable if proper design is employed. Their influence on the efficiency can be diminished, if the traction effect is rendered high by appropriate design of the blading.

Instruments and Regulators

A New Method of Evaluating Dynamic Response of Counterflow and Parallel-Flow Heat Exchangers, by H. M. Paynter, Mem. ASME, and Y. Takahashi, Massachusetts Institute of Technology, Cambridge, Mass. 1955 ASME Semi-Annual Meeting paper No. **55—SA-50** (multilithographed; to be published in Trans. ASME; available to April 1, 1956).

From the exact solutions for the frequency response of counterflow and parallel-flow heat exchangers, successive parameters are calculated which give direct information for the heat exchangers regarding transient responses as well as frequency responses. The numerical evaluations of the parameters from the design data of heat exchangers are generally very simple, although the formulas themselves appear somewhat involved. Good coincidence with measured transient responses is demonstrated on an example.

Application of Some Systems-Engineering Principles to the Design of a Fuel-Supply System, by A. E. Buescher, Jr., Assoc. Mem. ASME, and G. J. Fiedler, Sverdrup and Parcel, Inc., St. Louis, Mo. 1955 ASME Semi-Annual Meeting paper No. **55—SA-55** (multilithographed; available to April 1, 1956).

The purpose of this paper is to illustrate by example the benefits of "systems engineering" as applied to process controls. The example is an actual case history. Both dynamic and steady-state performance of the process are considered. Systems analysis prevents overemphasis of either the physical problem or the over-all performance requirements, so that the control configuration chosen is truly optimum and equipment selection is put on an economic basis. The control system designed is a fuel-supply system for an aircraft-engine test facility. The spacing limitations, performance requirements, and range of operating conditions are given. A design based on systems-engineering principles is outlined and methods for defining the functional requirements for components are derived. For reasons of brevity, the paper does not discuss the final design in detail; however, certain specific design problems are solved with emphasis on application and numerical work. A satisfactory mathematical relationship between flow and pressure is derived. Optimum mode of control for the system is found and control-valve location requirements are determined.

The Dynamic Response of Industrial Thermometers in Wells, by Thomas C. Linahan, Minneapolis-Honeywell Regulator Company, Philadelphia, Pa. 1955 ASME Semi-Annual Meeting paper No. **55—SA-52** (multilithographed; to be published in Trans. ASME; available to April 1, 1956).

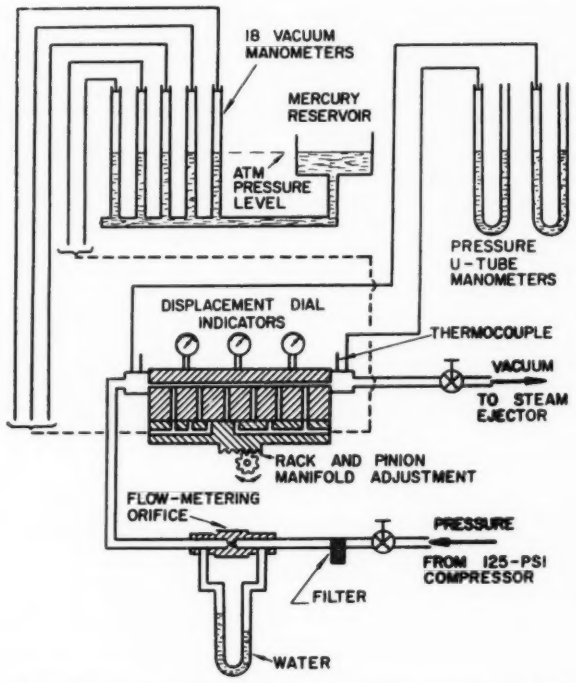
Previously published analyses of the dynamic response of thermometers in wells have neglected either the internal distributed well resistance or the internal bulb resistance. This paper considers an "effective" resistance and capacitance of the bulb when it is in a well. The distributed resistance and capacitance of the well are included, and an approximate second-order expression for the dynamic response is developed using a combined analytical and experimental approach. There is also a brief discussion of the film coefficient of heat transfer.

Machine Design

Flow of a Compressible Fluid in a Thin Passage, by S. K. Grinnell, Massachusetts Institute of Technology, Cambridge, Mass. 1955 ASME Semi-Annual Meeting paper No. **55—SA-13** (multilithographed; to be published in Trans. ASME; available to April 1, 1956).

Pressure distribution and weight-flow rate can be predicted for laminar compressible-fluid flow in a thin passage by use of the methods presented in this paper. A simplified method can be used readily when the fluid forces due to viscous action predominate over those due to acceleration of the fluid. A more complicated trial-and-error method seems to be required for larger passages where, though the flow may be laminar, the momentum effects due to acceleration of the compressible fluid are appreciable.

An experimental apparatus was used to examine the validity of the analytical work. Experimental pressure distributions agree within a maximum deviation of 10 per cent with the theoretical distributions predicted by both the comprehensive and simplified theories. Experimental weight-flow rates agree within a maximum deviation of 50 per cent with predictions of the simplified theory.



A schematic diagram of the general instrumentation and air supply and exhaust arrangement used in the experimental investigation of the pressure distribution and flow through a thin passage between flat plates

Dimensionless plots of pressure distribution are presented with experimental curves of flow rate versus pressure ratio for various ratios of passage length L to passage height b. These plots, together with simple equations, have been prepared for direct use by the designer.

The Effect of Bearings on the Dynamics of Overhung Turbines, by C. J. Maday, Assoc. Mem. ASME, Rossford Ordnance Depot, Toledo, Ohio. 1955 ASME Semi-Annual Meeting paper No. **55—SA-16** (multilithographed; available to April 1, 1956).

THE critical speed for a rotating machine usually is calculated only from the mass-elastic characteristics of the system. However, forces which will cause failure of overhung turbine bearings may be produced at steady operating speeds that are considerably below this calculated critical speed. The operating speed can be increased and the vibration decreased mainly by decreasing the bearing clearance and improving the wheel balance. These modifications also result in reduced bearing reactions and increased minimum oil-film thickness in the bearing. Performance curves computed for an overhung turbine show that the critical speed, determined only from the elastic properties of the rotor, cannot be used to predict the maximum operating speed of the machine. The bearing eccentricity ratio, the minimum oil-film thickness, and the magnitude of the bearing reactions also must be considered in determining the maximum safe operating speed of the turbine.

Long Shoe-Block Brake With Floating Anchor, by M. F. Spotts, Mem. ASME, Northwestern University, Evanston, Ill. 1955 ASME Semi-Annual Meeting paper No. **55—SA-21** (multilithographed; to be published in Trans. ASME; available to April 1, 1956).

IT IS beneficial for a brake or clutch with an internal shoe to be self-aligning and thereby affected in the least possible manner by any eccentricity of the drum or other dimensional variations in the parts of the assembly. This is achieved by connecting one end of the shoe to a floating link. In addition, the proportions should be arranged so as to cause the wear to be distributed as evenly as possible for all points of the lining. These desirable qualities can be achieved by means of the simple design equation presented.

In the paper, use is made of the symmetry of the face system on the lining to effect a great simplification in the design equations. A series of force polygons for a typical brake is presented which show how the proportions of a design should be arranged for achieving the desired operating characteristics.

Determination of Radius of Curvature for Radial and Swinging-Follower Cam Systems, by Martin Kloomok, International Business Machines Corporation, Endicott, N. Y., and R. V. Muffley, Assoc. Mem. ASME, International Business Machines Corporation, San Jose, Calif. 1955 ASME Semi-Annual Meeting paper No. **55—SA-29** (multilithographed; to be published in Trans. ASME; available to April 1, 1956).

AN exact derivation has been given for radius of curvature of a cam-follower path. The equations are applicable to any motion curve, but the labor of computation suggests evaluation by means of a high-speed computing machine, such as the IBM Card-Programmed Calculator. The resulting data for harmonic, cycloidal, or other motion curves are then graphed to facilitate use in design, as indicated in the paper.

The graphs speed up the process of calculation to the point where it is possible to experiment with small changes in the parameters and thereby avoid serious difficulties in radius of curvature early in the design, before the cam has been detailed or calculated.

On the Maximum and Minimum Velocities and the Accelerations in Four-Link Mechanisms, by Ferdinand Freudenstein, Assoc. Mem. ASME, Columbia University, New York, N. Y. 1955 ASME Semi-Annual Meeting paper No. **55—SA-20** (multilithographed; to be published in Trans. ASME; available to April 1, 1956).

A METHOD of analysis has been developed for obtaining (*a*) geometrical criteria for an extreme value of the angular velocity ratio of one link relative to another in a four-bar mechanism, and (*b*) a direct method of determining the angular acceleration of the follower link of a four-bar mechanism, and maximum values of this acceleration in certain special cases. The results have been applied to a slider-crank mechanism.

The Effect of Oil-Column Acoustic Resonance on Hydraulic Valve "Squeal," by F. W. Ainsworth, Minneapolis-Honeywell Regulator Company, Minneapolis, Minn. 1955 ASME Semi-Annual Meeting paper No. **55—SA-14** (in type; to be published in Trans. ASME; available to April 1, 1956).

AN outline is presented of a theory that

oil-column resonance is one likely cause of control-valve oscillation. It is shown analytically and experimentally that acoustic resonance of the oil in the lines which are attached to the valve can cause an otherwise stable valve to squeal. To eliminate the instability, the oil lines should be (1) made as short as possible by moving the accumulator as close as possible to the valve, and (2) as dissipative as possible; also, adding a viscous damper to the valve plunger will help.

Applied Mechanics

Large Plastic Deformations of Circular Membranes, by N. A. Weil, The M. W. Kellogg Company, New York, N. Y., and N. M. Newmark, Mem. ASME, University of Illinois, Urbana, Ill. 1955 ASME Applied Mechanics Conference paper No. **55—APM-20** (in type; to be published in the *Journal of Applied Mechanics*).

An investigation is presented for the plastic behavior of clamped circular membranes subjected to hydrostatic pressure, based on the Hencky-Mises theory. New strain-displacement relations, valid for finite deformations in the plastic domain, are introduced.

The solution is presented in terms of two simultaneous implicit integral equations, which can be solved by numerical methods. The solution also permits the formulation of the instability condition. Experimental work consisted of bulge tests carried out on annealed copper plates of two thicknesses, whose τ-γ curve was previously determined from uniaxial tests. A good correlation is obtained between theoretical predictions and experimental results.

Shortcomings of Present Methods of Measuring and Simulating Vibration Environments, by C. T. Morrow, Hughes Aircraft Company, Culver City, Calif., and R. B. Muchmore, The Ramo-Wooldridge Corporation, Los Angeles, Calif. 1955 ASME Semi-Annual Meeting paper No. **55—SA-2** (in type; to be published in the *Journal of Applied Mechanics*).

This paper concerns itself with the problem of measuring a vibration environment to be encountered by a delicate instrument or electronic device in the field and of attempting to simulate the vibration in laboratory test as a check on the reliability of the design.

Field vibration is usually either random in time or of a fixed frequency nature. Until recently, the vibrations applied in laboratory test have been fixed frequencies applied at resonances, or single-frequency sweeps. In general, it is not possible to simulate one type of vibration by another, except in special cases, or to express measured data of one type in the language of another without loss of accuracy. For example, it is not valid to analyze random vibration in terms of number of g versus frequency. When the vibration to be encountered is random, the vibration applied in test for proof of design should likewise be random, and single-frequency sweeps should be used only for proof of workmanship with a specification based on the design limits of the item. Random vibration can be applied through the use of an electronically driven vibrator.

A procedure for analyzing a random vibration and deriving a specification is presented.

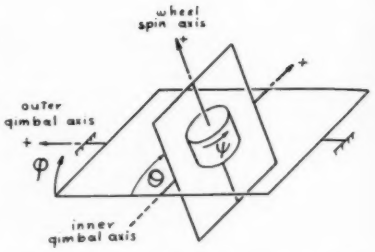
Inertia Forces in Lubricating Films, by R. S. Brand, Assoc. Mem. ASME, University of Connecticut, Storrs, Conn. 1955 ASME Semi-Annual Meeting paper No. **55—SA-1** (in type; to be published in the *Journal of Applied Mechanics*).

The usual theory of hydrodynamic lubrication is based on the assumption that the inertia forces in the equations of motion are negligible compared to the viscous forces. This paper shows that if the Reynolds number $\rho R\omega h/\mu$ is of the same order as R/h, then the inertia forces will be of the same order as the viscous forces.

Nutation of a Free Gyro Subjected to an Impulse, by B. T. Plymale and R. Goodstein, Boeing Airplane Company, Seattle, Wash. 1955 ASME Semi-Annual Meeting paper No. **55—SA-3** (in type; to be published in the *Journal of Applied Mechanics*).

This paper calls attention to a particular gyro motion which has been observed and studied in our laboratories.

Consider the gyro shown in the accompanying diagram. The wheel and gimbals are balanced, the bearings have negligible friction, and windage is negligible. Hence no external torques are acting on the system, and the wheel and gimbal assembly maintains a fixed position in space. Now, if either the inner or outer gimbal is struck sharply with a hammer, imparting an impulse to the system, a wobbly motion of the wheel occurs which, in the absence of dissipative torques, would persist indefinitely. This motion is referred to as "nutation." It is observed that for small angular displacements the motions of the inner and outer gimbal are approximately sinusoidal. However, closer examination and testing reveal that when the inner and outer gimbals are not initially perpendicular, the inner gimbal will oscillate about a fixed center position but the outer gimbal will exhibit oscillations accompanied by a steadily increasing angular displacement of the "center" position of the oscillations. It is this average angular rate accompanying the outer gimbal oscillations which can lead to loss of reference in a free-gyro instrument.



Configuration of the free gyro is specified by the three angles ψ, θ, and φ shown. ψ is the angular position of the wheel relative to the inner gimbal, θ is the angular position of the inner gimbal relative to the outer gimbal, and φ is the angular position of the outer gimbal relative to inertial space, with the positive directions as shown.

The phenomenon is of extreme practical importance for all instruments which use a gyro as a space-stable element, and no published usable information has been found concerning it. A description and explanation of the motion is presented. An Appendix contains the basic equations for the system and the results of approximate solutions.

Torsion of Circular Shafts of Variable Diameter, by M. M. Abbassi, Alexandria University, Alexandria, Egypt. 1955 ASME Applied Mechanics Conference paper No. **55—APM-19** (in type; to be published in the *Journal of Applied Mechanics*).

By using spherical polar co-ordinates, the stress function for circular shafts of variable diameter is expressed in terms of the Legendre associated functions of the second order. It is obtained for various curves forming the generating surface of the shaft.

The Permanent Deflection of a Plastic Plate Under Blast Loading, by A. J. Wang, Illinois Institute of Technology, Chicago, Ill. 1955 Applied Mechanics Conference paper No. **55—APM-1** (in type; to be published in the *Journal of Applied Mechanics*).

This paper is concerned with a simply supported circular plastic plate that is exposed to a strong blast. Equations of deformation are developed.

In determining the deflection of the plate in this problem, it is assumed that the blast imparts instantaneously the transverse velocity u_0 to the entire plate and that thereafter the plate is free from transverse loads. The plate is supposed to have uniform thickness and to consist of a perfectly plastic-rigid material that obeys Tresca's yield condition and the associated flow rule.

Limits of Economy of Material in Plates, by H. G. Hopkins and W. Prager, Mem. ASME, Brown University, Providence, R. I. 1955 ASME Applied Mechanics Conference paper No. **55—APM-2** (in type; to be published in the *Journal of Applied Mechanics*).

THE paper is concerned with the limits of economy of material in a simply supported circular plate under a uniformly distributed transverse load. The plate material is supposed to be plastic-rigid and to obey Tresca's yield condition and the associated flow rule. The criterion of failure adopted is that used in limit analysis.

It is shown that the plate of uniform thickness has a weight efficiency of about 82 per cent.

Stepped plates of segmentwise constant thickness are discussed, and the plate of continuously varying thickness is treated as the limiting case obtained by letting the number of steps go to infinity.

Plastic Deformations of a Free Ring Under Concentrated Dynamic Loading, by R. H. Owens, Office of Naval Research, Washington, D. C., and P. S. Symonds, Mem. ASME, Brown University, Providence, R. I. 1955 ASME Applied Mechanics Conference paper No. **55—APM-27** (in type; to be published in the *Journal of Applied Mechanics*).

A CONCENTRATED time-dependent force acts on an unsupported thin ring along a diameter.

The problem considered in this paper is to determine the deformations of the ring when the force magnitudes are such that plastic strains are large compared with elastic strains. By neglecting elastic strains and assuming ideally plastic behavior, approximations to the final deformations of the ring are obtained.

The analysis is developed for force pulses of arbitrary shape, but numerical results are obtained only in the special case of a rectangular force pulse. A criterion is stated for conditions when this type of analysis can be expected to provide satisfactory results.

ASME Transactions for July, 1955

THE July, 1955, issue of the Transactions of the ASME (available at $1 per copy to ASME members; $1.50 to nonmembers) contains the following:

Technical Papers

Application of High-Speed Strain-Gage Torquemeter to Turbomachinery Research, by H. A. Buckner, Jr., and J. J. Rebeske, Jr. (54—SA-23)

The Combustion-Efficiency Problem of the Turbojet at High Altitude, by W. T. Olson, J. H. Childs, and E. R. Jonash. (54—SA-24)

Heat Transfer From Spheres to a Rarefied Gas in Subsonic Flow, by L. L. Kavanau. (54—SA-52)

A Note on Limiting Laminar Nusselt Number in Ducts With Constant Temperature Gradient by Analogy to Thin-Plate Theory, by S. M. Marco and L. S. Han. (54—SA-46)

Safe Stress Range for Deformation Due to Fatigue, by M. Kawamoto and K. Nishioka. (54—SA-10)

Dynamic Loads on Spur and Helical-Gear Teeth, by J. B. Reswick. (54—SA-9)

The Grinding of Titanium Alloys, by C. T. Yang and M. C. Shaw. (54—SA-57)

Working-Stress Criteria for Nuclear-Power Plants, by B. F. Langer. (54—SA-59)

The Thermal Design of Nuclear-Power Reactors, by N. J. Palladino. (54—SA-58)

Graphical Representation of the Frictional Losses in Commercial Pipe of Air and Steam Flowing Turbulently at Low Pressure, by W. C. Knapp and J. W. Metzger. (54—SA-17)

Fanning Friction Factors for Air Flow at Low Absolute Pressures in Cylindrical Pipes, by W. J. Bohnet and L. S. Stinson. (54—SA-16)

Interaction of Friction and Temperature at the Chip-Tool Interface in Metal Machining, by F. F. Ling and Edward Saibel. (54—SA-2)

Dielectric Breakdown Properties of Thermosetting Laminates, by N. A. Skow. (54—SA-67)

Thermodynamics of Supercritical-Pressure Steam-Power Plants, by Jerome Bartels. (54—F-37)

An Introduction to the Thermal Problems of Turbojet Engines for Supersonic Propulsion, by A. J. Gardner. (54—A-155)

Effect of Supersonic Flight on Power-Plant Installation Systems, by R. B. Keusch. (54—A-156)

An Investigation of the Melting of Bodies Due to Aerodynamic Heating, by C. H. McLellan. (54—A-157)

Temperature Problems of Equipment in High-Speed Aircraft, by H. W. Adams. (54—A-131)

Personnel and Equipment Cooling in Supersonic Airplanes, by J. Makowski and V. L. Whitney, Jr. (54—A-206)

Human Problems Associated With High-Speed and High-Altitude Flight, by R. A. McFarland. (54—A-230)

The Thermal Barrier—Structures, by N. J. Hoff. (54—A-207)

Some Structural Aspects of Thermal Flight, by George Gerard. (54—A-40)

Problems in the Design of Aircraft Subjected to High Temperature, by F. R. Steinbacher and Louis Young. (54—A-100)

Carbon-Molybdenum Steel Steam Pipe After 100,000 Hours of Service, by R. J. Sinnott, I. A. Rohrig, J. W. Freeman, and A. I. Rush. (54—A-73)

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Comments on Papers

Including Letters From Readers on Miscellaneous Subjects

Varying Standards on Licensing Registration of Engineers

To the Editor:

ENGINEERS or representatives of corporations seeking to practice engineering in New York State have sponsored enabling bills for the past three years before legislative committees. None of the various bills has reached the floors of the two houses. In an attempt to harmonize viewpoints, the National Society of Professional Engineers agreed this past year to accept a provision that two thirds of the directors of an engineering corporation must be licensed professional engineers. Even this concession was not enough to get the approval of many opponents of corporation practice. Various prominent engineers were opposed as well as the American Institute of Consulting Engineers, New York Association of Consulting Engineers, American Institute of Architects, American Society of Civil Engineers (Metropolitan Section), and the New York Association of Architects.

As licensing or registration of professional engineers broadens its impact, the problem becomes increasingly important to all engineers who seek higher professional standards. So even the ASME should listen to an argument as to another weakness in corporation practice of engineering. I refer to the varying standards in the different states as to the licensing or registration of professional engineers.

Assume an engineering corporation has a job in State A with high standards for professional engineers. The corporation's assistant in direct charge of the job, who is a professional engineer in State A, has to report to the president in State B which has low standards. The corporation's president who is licensed in State B as a professional engineer cannot obtain a license in State A.

Some states will accept as professional engineers those who could not, or have not, passed examinations in the basic sciences or in engineering practice. They are probably mainly sales engineers or those with only practical experience.

So we have the president of the corporation in State B with low qualifying standards dictating to an assistant in State A with high qualifying standards. The assistant who may have strong reservations on instructions issued either does as he is told or loses his job.

Gregory M. Dexter.[1]

Cooling for Reactors

Comment by Herbert Saunders[2]

THE author[3] has done an excellent job in discussing and detailing many of the design difficulties that arise in reactor design. The design of nuclear-reactor containers is similar to pressure-vessel design as practiced in refinery and chemical plants but has the added difficulties of using austenitic steel with its inherent problems plus the complications of thermal stresses.

As the author mentions, if not considered, thermal stresses would cause great duress to the system. The use of thin walls is usually stressed in powerplant, refinery piping, and pressure vessels to minimize the temperature gradients and thus reduce the resulting thermal stresses. This is not too different from reactor-container design. In order to reduce the transient thermal stresses, the use of baffles, as discussed by the author, is similar to applications in other fields. By allowing a certain amount of play or "slop," the member acts as a partially restrained cantilever which greatly reduces the stress at the clamped end, giving added damping to the system, and aids in attenuating the transients. Because of the low partial pressure of sodium, the usual seals at high pressures are not a problem in this design, but they must be leakproof. The writer would like to inquire if the 400 series of ferritic-type stainless steel has ever been considered in the design of the container. The ferritic stainless steel, especially 422, has the added advantage of much greater allowable creep-stress value at high temperatures and lower thermal expansion than austenitic stainless steels. This should help reduce the thermal-stress problem.

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[2] Research Engineer, Grumman Aircraft Engineering Corporation, Bethpage, Long Island, N. Y. Assoc. Mem. ASME.

[3] "Liquid-Metal-Cooled Reactors," by C. R. Stahl, MECHANICAL ENGINEERING, vol. 76, December, 1954, pp. 978–980.

Author's Closure

The comments of Mr. Saunders concerning the similarities between liquid-metal-cooled reactor-design problems and those of containers for the refinery and chemical industry are very interesting. His comment about the use of ferritic-type stainless steels is a good one and the use of these steels is being explored. The choice of a structural material in reactor design depends, however, upon many other factors than those mentioned here. For example, the nuclear and corrosion characteristics play a large role in material selection. In order to use a different material, enough experience must be accumulated to insure acceptability in all areas.

C. R. Stahl.[4]

Radioactive Waste Disposal

Comment by Earl Devendorf[5]

THE authors[6] have presented a comprehensive outline of the problems relating to the disposal of radioactive wastes. The outline of the kinds of wastes encountered, the sources of the wastes, their levels of activity and current methods of treatment and disposal are valuable information to the engineers, physicists, and others concerned with this problem.

The research and development activities of the Atomic Energy Commission have been broad in scope and intensive in nature in an effort to solve the

[4] Knolls Atomic Power Laboratory, Schenectady, N. Y.

[5] Director, Bureau of Environmental Sanitation, State of New York, Department of Health, Albany, N. Y.

[6] "Disposing of Radioactive Wastes," by Abel Wolman and A. E. Gorman, MECHANICAL ENGINEERING, vol. 77, April, 1955, pp. 321–324.

problems associated with the use, storage, and disposal of radioactive materials.

As a state sanitary engineer, the writer is particularly concerned with the ever-increasing use of ionizing radiation and its effect on the environment. Aside from the increasing use of x-ray and radioisotopes, the fallout from nuclear bomb tests and wastes from nuclear reactors, all of which are now contributing to the environmental radiation exposure, state sanitary engineers are concerned in anticipating what the problems will be five, ten, or twenty years from now.

As the authors indicate, tremendous amounts of radioactive wastes will be produced as the result of the operation of atomic-power development, and the development of more economic methods for the safe disposal of such wastes must be accomplished as the atomic-energy industry moves forward.

The development of skill in radiation matters by state and local health units will assist materially in the orderly development of atomic energy. They are the ones who should be able to evaluate the effect of added radiation to the environment in a community.

The members of this Society will be interested to know that on November 19, 1954, the Public Health Council of the State of New York enacted a new Chapter of the Sanitary Code for the control of ionizing radiation, which will become effective July 1, 1955.[7] This new Chapter of the Code contains specific regulations relating to all radioactive wastes discharged to the environment.

Comment by M. D. Hollis[8]

The Public Health Service finds it useful to think in terms of three levels of radiation:

1 Relatively high levels are associated with fuel processing and some phases of the weapons' program. These levels are under strict control by the AEC within its own installations. It is hoped that the AEC and the atomic-energy industries will continue successfully to confine the materials emitting high levels of radiation.

2 There are low levels, detectable and measurable through the ultrasensitivity of instrumentation, which present no significant health hazard. The public will soon learn that there is no need to experience either alarm or injury from this class of radiation.

3 Levels within the range of the maximum permissible dosages and amounts may, on occasion, affect the environment beyond the boundaries of the AEC installations. Public-health agencies maintain surveillance of such radiation.

Since radioactivity persists despite treatment or confinement, everyone agrees that mistakes or accidents create health hazards of a new type and scale. When one is dealing with radioactivity, merely removing radioactive isotopes from a liquid does not necessarily remove the hazard. As a matter of fact, treatment of dilute waste could produce external radiation hazards through concentration of the radioactive isotopes.

Industrial Reactors

It has been shown, through research conducted in co-operation with the AEC at Oak Ridge, that safeguarding public health should be attained primarily through the proper disposal of radioactive wastes requiring treatment, segregation, and storage, rather than by dependence upon the treatment of water supplies. Further, research has demonstrated that presently known methods of disposal of radioactive wastes, unless modified and improved, might create an economic burden in the industry which may be a decisive factor.

Brief economic studies indicate that all methods of ultimate disposal currently under consideration may prove too costly for commercial use. It is quite proper, therefore, to consider research leading to the constructive use of one or more of the critical isotopes, so that their commercial use can help reduce the cost of proper disposal of radioactive materials.

To assist the growth of this industry further, health agencies must also develop uniform requirements for site selection and waste disposal which have a sound technical basis.

Assuming that we utilize the standards of the National Committee on Radiation Protection as a base, we can develop fair and practical methods of analysis for specific isotopes and groups of isotopes. Work of this type is under way at the Robert A. Taft Sanitary Engineering Center in Cincinnati. The Center is developing methods which will accurately appraise radioactive hazards in water resources to be used in lieu of the gross-calculation procedures presently in use.

The emerging atomic-energy industry challenges the entire engineering profession. The writer is confident that ways will be found to utilize this magnificent source of energy in the best interests of all.

Comment by Morris M. Cohn[9]

The courage and imagination with which the atomic-energy industry has tackled production is matched by the pioneering spirit with which the back-breaking job of cleaning up its unwanted "garbage" has been handled. Nothing can be added to what the authors have said about these problems and practices. However, there is another factor to be handled carefully with the same imagination characterizing the past decade.

The atomic-energy industry faces a twofold task in disposing of its wastes: (1) It must provide the answers to the new, scientific problem of finding effective, safe, and economical methods of handling potentially hazardous wastes in liquid, solid, and gaseous form; (2) it must solve an old and totally unscientific problem of human relations.

It is astonishing how well the technical problem of wastes disposal has been handled, by intelligent application of air-purification principles, liquid-wastes-treatment practices, water and air-dilution phenomena, and high-temperature incineration conditions. Broadly speaking, disposal methods have been safe; if anything, they have been too safe to meet the challenge of economy voiced by the authors.

What may not be known is that the Atomic Energy Commission has also performed well in the field of human relations—building confidence in the public mind that its operations are being carried out without hazard to the nation.

Nothing that has happened in the nuclear-development field would tend to allay the fears of a public which always fears what it does not understand. Certainly, what happened in Hiroshima did not help, nor have reports of what happened in the atolls in the South Pacific.

Mohawk River Advisory Committee

It is well to know, therefore, of one specific public assurance effort of AEC, as typified by the creation of the Mohawk River Advisory Committee to act as "public representatives," as it were, in reviewing the sanitary and safety measures being utilized by the Knolls Atomic Power Laboratory at Schenectady, N. Y. This laboratory is located in an area populated by a highly cosmopolitan people living in a civic-minded community, having a healthy questioning attitude and high standards of cleanliness and environmental sanitation, even to the point of fighting for pollution control in the Mohawk River and air-pollution control in an industrial climate.

[7] This effective date has been rescinded pending further study of the regulations.

[8] Assistant Surgeon General and Chief Engineer, Public Health Service, Department of Health, Education, and Welfare, Washington, D. C.

[9] Knolls Atomic Power Laboratory, Schenectady, N. Y.

To help translate the sanitation needs of the area to the operations at KAPL and, conversely, to interpret the safety practices of KAPL to the public, AEC, in conjunction with the General Electric Company, the contractor-operator of this installation, set up an advisory group composed of the State Commissioner of Health, the Deputy State Commissioner, the State Director of Environmental Sanitation, the Executive Secretary of the State Water Pollution Control Board, and the writer, serving as the local community official most intimately associated with sanitation and governmental administration.

This group has served as the liaison between the AEC project and the public. By its very composition, the committee served as assurance to the public that the same standards of public safety applied to routine health problems were being applied to the new and less understood problems of experimenting with nuclear energy.

This group has done what the Atomic Energy Commission has most wanted done; namely (1) helped to evaluate and guide wastes-disposal practices in terms of environmental safety; and (2) served as a bridge between new, unknown and old, known environmental control practices, by spanning the deep and mysterious chasm of public misinformation and doubts.

Metallic Friction

Comment by R. Schnurmann[10]

THE authors[11] very properly state that friction between solid bodies is "a complicated phenomenon." Our current views on the subject are of a phenomenological nature. The real significance of Amontons' law of the direct proportion between the force of friction and the normal load is that it offers a criterion for discriminating between "sliding" and "tearing" (1).[12] In cases of sliding, the surfaces emerge undamaged as judged by unaided visual inspection. It is only in these cases that the coefficient of friction has a defined value.

Value of Amontons' Law

Whenever the surfaces of two solid bodies in frictional contact suffer damage which becomes apparent to the naked eye, a record of the variation of the force of friction would show that it increases at a more than proportionate rate with the normal load. Under such conditions the ratio between the force of friction and the normal load varies. Usually it increases because once tearing, or grooving, or gouging begins, it goes on at an accelerated rate, although there may be periods at which some torn-off particles become ground to dust with a temporary decrease in the ratio between the force of friction and the normal load. There is a transition region from sliding to tearing as determined by visual inspection of the surface emerging from frictional contacts.

It is one of the virtues of Amontons' law that it more closely defines the transition from sliding to tearing than does observation of the surfaces with the naked eye. Indeed it gives the only reasonable criterion since by refining the optical means of observation one is bound to find always, even under conditions of sliding, some transfer of matter as has been shown by the development of metallic "traces" (2) and with the help of radioactive indicators (3).

Magnitude of Coefficient of Friction

In the region of normal loads within which the coefficient of friction is defined, its magnitude depends entirely upon the operating conditions of the frictional contact and mainly upon the question whether relative motion takes place under "dry" conditions or upon the lubricating quality of the material which is sandwiched between the actual area of contact.

For any gliding movement, the coefficient of friction must be of the order of unity in the ideal case of dealing with naked surfaces; i.e., surfaces which are quite bare of any condensed or adsorbed matter and which are also free of oxide or sulphide films. The experimental difficulty is to establish conditions for working with naked surfaces. There is some immediate onset of recontamination even of surfaces which have been cleaned by volatilization in a high vacuum.

Monomolecular Film

From the pressure of the residual gas, the accommodation coefficient of the gas with respect to the solid surfaces and their areas, the time can be estimated for the formation of a contaminating monomolecular film.

In one experiment in which the coefficient of static friction of cadmium was measured in the same vacuum in which the solid surfaces had been cleaned by volatilization while the friction elements were out of contact, the measured angle of repose corresponded to a coefficient of friction of the order of unity (4). Appreciably larger values would seem to indicate that a very thin adhesive film of foreign matter had formed between the friction elements, although initially they might have been subject to cleaning by volatilization.

When such adhesive films play a part, then the apparent coefficient of friction is actually the ratio between the normal load and the shear strength of the weakest part in the combination solid body/boundary film/solid body. If, under these conditions, the normal load is very large in comparison to the shear strength of the weakest part of the assembly of friction elements, the ratio between the force of friction and the normal load appears to be small and, on the other hand, for comparatively light loads the frictional force may then appear to be large compared to the normal load.

Adhesive Action of Thin Films

The very strong adhesive action of extremely thin films is clearly demonstrated by casting a metal cylinder at a temperature close to the melting point of the metal onto a clean glass plate (2). The metal cylinder then adheres tenaciously to the glass plate.

The idea of regular interlocking of the surfaces of two solid bodies in contact was first expressed by de la Hire (5). It is quite clear, however, that even though the two solid bodies may suffer plastic deformation under the action of a normal load, deformation of their surfaces cannot be such as to form interlocking regular corrugations which would give rise to a resistance to movement under the action of a tangential force that is independent of the orientation of the tractive force within the plane of contact. There is also against the mechanism outlined in Figs. 2 and 3, and in favor of the model illustrated by the authors' Fig. 1, the fact that the actual area of contact is a small proportion of the nominal area of contact as long as Amontons' law is obeyed and that the "traces" which can be developed on a glass plate (2) after a piece of metal has been moved over it are widely spaced and irregularly distributed.

Electrostatic Component of Friction

With regard to the authors' reference to the electrostatic component of the force of friction (6), the position is that experimental evidence has been produced to show that the force of friction can have an appreciable electrostatic component when the operating conditions are such that static charges can be fixed to at least one of the contact areas (6, 7).

[10] Chief Physicist, Manchester Oil Refinery, Ltd., Manchester, England.

[11] "Metallic Friction and Lubrication by Laminar Solids," by E. Koenigsberg and V. R. Johnson, MECHANICAL ENGINEERING, vol. 77, February, 1955, pp. 141–147.

[12] Numbers in parentheses refer to the Bibliography at the end of this comment.

This would appear to be a very different view from the authors' allegation that "a theory which asserts that friction is often of an electrostatic nature has been proposed. . . . . ."

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6 "The Electrostatic Component of the Force of Sliding Friction," by R. Schnurmann and E. Warlow-Davies, Proceedings of the Physical Society, London, England, vol. 54, 1942, pp. 14–27.

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Authors' Closure

The importance of Amonton's law for practical applications should not be minimized as Dr. Schnurmann very appropriately points out. However, the present authors were concerned with the fundamental nature of metal-to-metal friction in which case the emphasis on the proportionality of friction to the actual area of contact appears to be more appropriate. The practical rather than fundamental nature of the original form of Amontons' law is clearly indicated by the boundary of the range of validity being defined by whether or not "the surfaces . . . suffer damage which becomes apparent to the naked eye."

The occurrence of welding in metal-to-metal friction appears to be well established. The important questions are: How large is its contribution to the frictional force, and in what way does it occur? In regard to the first question, Dr. Schnurmann correctly suggests that the first problem experimentally is to establish the condition of the sliding surfaces. However, his differentiation fundamentally between bonding of two clean surfaces by a thin film (as, in his example, casting metal on glass) from clean metal to clean-metal bonds formed by exerting a given normal force would seem to be artificial. In both cases the force necessary to shear the bond will be the product of the shear strength and the actual area of contact, although the magnitudes of these areas may differ considerably depending on the method of formation. In regard to the second question mentioned with reference to the "weld-interlock" theory, it was the present authors' suggestion that the strength of this theory lies in the fact that it accounts for wear particles.

The presentation of Figs. 2 and 3 was not intended to show an actual contact interface but an idealized picture as was clearly brought out by the actual electron micrographs in the original reference.[13] Furthermore, there is no difference between the weld-interlock and the "weld theories" as regards the actual areas of contact. Both assume contact between only a relatively few surface asperities. (Figs. 2 and 3 represented only a single asperity.) On the other hand, it must be admitted that the physical picture from the weld-interlock theory is difficult to visualize for actual sliding contacts and perhaps even more difficult to obtain experimentally. There is need for further work before a completely adequate picture is obtained.

Ernest Koenigsberg[14] and V. R. Johnson.[14]

Research

Comment by David J. Bloomberg[15]

For many years the writer has been engaged in research work with the General Electric Company, so the paper[16] is of considerable personal interest.

The founders of the company early recognized (around 1900) that research called for a different type of personality than did production. There were two separate groups (research and production or commercial engineers) and each group worked independently of the other. In fact, they were antagonistic at times.

Present-day organization planning apparently is trying to keep the research group free of the control of the commercial group. The writer, however, feels that some means should be found to go much further in the separation as far as control is concerned. Organization planners should put the research group on at least as high a level as the production group and provide them with a source of revenue in the form of research contracts. This will provide them with responsibilities and the authority that goes with responsibilities.

Comment by H. O. Davidson[17]

While the author's analysis should be easily followed by persons familiar with the development of operations research, there are parts of his paper which might not be entirely clear to other readers. Thus he states in one place "that the criteria of good operations research are ability to overcome organizational obstacles . . .," etc., while two paragraphs later he writes "Optimally, operations research is science and takes place as scientific research . . . The prime test of the success of research is one of validity, completeness, and logic . . ." In fairness to the author it should be stated that whatever appearances of contradiction may be involved in these statements are not so much of his making as they are consequences of an attempt to embrace within the scope of his paper the spectrum of current views on operations research.

It does appear, however, that he draws upon one of the extreme views in making the suggestion (if only for argument) that "optimally, operations research is science." This view is not in fact held on any grounds of optimality, but "by definition." It is a definition which has gained currency more by covenant than by its value as a description of what most practitioners of operations research are really doing. The majority of persons employed by established operations-research groups would, in our opinion, probably support the position that conduct of their activity according to the patterns and precepts of pure scientific research would be definitely not optimal.

It is quite true that one will find a predominance of scientific training in the backgrounds of the professional people in these groups, and this—as the author suggests—is an asset of considerable value. At the same time, the success of these groups seems to be rather closely related to their ability to assume the engineering viewpoint. This means that it is rather difficult to draw any clean-cut contrasts of viewpoints and objectives.

The author is most successful in establishing a differentiation on the basis of relative emphasis on (or competence in) the two basic forms of activity which we would call analysis and synthesis, i.e., design. We would agree with his observation that certain techniques of

[13] "Metal Transfer and Wear," by I-Ming Feng, *Journal of Applied Physics*, vol. 23, 1952, p. 1011.

[14] Senior Physicists, Engineering and Science Division, Midwest Research Institute, Kansas City, Mo.

[15] Consultant, Newton, Mass. Mem. ASME.

[16] "Operations Research," by A. Schultz, Jr. Mechanical Engineering, vol. 77, February, 1955, pp. 148–150.

[17] Chairman, Targets Group, Operations Research Office, Chevy Chase, Md.

analysis employed in operations research probably could be adopted to advantage by the production engineer. At the same time we would be inclined to make explicit what the author seems merely to imply; that within the restrictions under which the production engineer operates he may be at least as good if not a definitely better "artful synthesizer" than the operations-research practitioner.

Comment by John K. Diederichs[18]

The author clearly points up three major areas of contrast by which he indicates the difference between operations research and production engineering or, in fact, any other engineering activity; viz., organizational restrictions, economic restrictions, techniques, and methodological resources.

From our experience with the across-the-board and top-level-management mode of operation, we do not find the organizational restriction that the author stresses.

The author feels that operations research should not be subject to the same economic restriction as production engineering, management engineering, and so on. If the sense of his thought were to carry the meaning "to the same extent," the writer would agree. It is believed, however, that when the author refers to "research" in operations research he means the more fundamental variety—the sort carried on in academic institutions not subject to time pressures and the money limitations so familiar in industrial experience. Also, it is felt that he is making his plea for support by pointing out this difference between the more specific engineering areas and operations research.

Our experience has shown us that management inherently thinks in terms of time and cost. Perhaps the author implies that time and money should be allowed for really researching an operational problem with no guarantee of improvement or even a justification of the time and money spent. Ideally, the writer agrees—but practically, he feels that experience has shown that the nonguarantee of return type of program is a rough one to sell.

As management consultants, one of our objectives is to be aware of and develop specific applications of the generalized solutions to the major problem types that are the concern of the more fundamental operations researcher. It is our purpose to carry to the engineer and/or management the effectiveness of those newly developed techniques which, in our opinion, are deemed applicable and where foreseeable results may be expressed in the executive's language.

[18] Booz-Allen and Hamilton, Management Consultants, Chicago, Ill.

Comment by D. G. Malcolm[19]

Essentially the argument proffered by the author is that the production engineer could do a better job if he were to be provided with more assistance by way of research related to the variables involved in his particular design area.

In reading the paper one might well feel inclined to ask the following question: If the organizational and economical barriers were to be removed by management could, or should, production engineers do considerably more research on their own system design problems?—providing, of course, approval to hire adequate staff also were given. It would therefore appear that the author has failed to answer a couple of questions which most likely will be raised in the mind of the production engineer:

1 If I am so restricted organizationally and economically, how do I get such research assistance? Should I attempt to strike the spark?

2 Where should this research be organized or administered? The "integral function" mentioned by the author lacks sufficient definition or elaboration to be meaningful.

Another distinction between production engineering and the research approach which should be pointed out lies in the fact that the engineer's responsibility generally extends through what may be called the "installation" phase of his work. He is held directly responsible for his design and generally supervises working out any difficulties that may arise during tryout or installation. The researcher, at least to date, generally ceases to be concerned with the problem after his recommendations have been accepted. Of course several unsuccessful installations would most likely reflect back an unsatisfactory evaluation of his research ability. Perhaps this will help to delineate the proper organization of such a research activity.

In most larger industries it appears that we are witnessing a broadening of the various engineering and planning departments' problems to a point of serious convergence, interrelation, and duplication. A solution to this difficulty may lie in the formulation of a centralized function to perform research on how the particular business or industrial system functions. Such a staff organization could well serve several of the planning and engineering departments of the company. Certainly industrial engineering, or production engineering as defined by the author, could well benefit by such research properly conceived.

[19] Operations Research Office, Chevy Chase, Md. Mem. ASME.

Authors's Closure

Both Mr. Diederichs and Dr. Davidson point out the difficulty of conducting true research on operations and imply that the pressure for an immediate payoff or answer is such that the result is more like engineering than research. Dr. Davidson also emphasizes the importance of the engineer's function of synthesis or design. One of the most intriguing aspects of the dynamically developing field is the possibility that out of the new computational developments of recent years, combined with the greater analytical ability emerging, there will result techniques which make it possible for the engineer to evaluate his designs more objectively and perhaps approach more rapidly an optimum.

Mr. Malcolm has touched upon a very important aspect of industrial research. To date, industry or government has performed or sponsored little research upon operations. The question as to who should perform such research has not yet been settled, and there are many other problems besides the position of the production engineer in such research. His other point related to implementation is an important one also, and again the inference resulting is that those who take part in implementation stray further from research and become operators rather than scientists.

Collectively, the comments point out a number of serious problems any operations-research organization must face, since all the pressures, as well as the method of evaluation, tend to dilute the quality of the research in favor of immediate answers and results. Perhaps the inevitable result may be the absorption of the whole conception and procedure by a new type of industrial engineer whose procedures of analysis and synthesis are founded upon scientific bases, superior to those currently in general use.

A. Schultz, Jr.[20]

The Hyperforming Process

Comment by E. Hander[21]

ALTHOUGH the flow scheme, presented in the paper,[22] does not show any

[20] Professor, Sibley School of Mechanical Engineering, Cornell University, Ithaca, N. Y.

[21] Materials Department, Asiatic Petroleum Corporation, New York, N. Y. Mem. ASME.

[22] "Mechanical Features of the Hyperforming Process," by Clyde Berg, MECHANICAL ENGINEERING, vol. 77, January, 1955, pp. 19–22.

facility for catalyst make-up or adding catalyst, is it correct to assume the author's hyperforming unit would be so equipped? If so, how is it accomplished and at what point is the catalyst injected?

Comment by R. W. Helsel[23]

Pertaining to the reactor used in the hyperforming process:

1 Of what size and shape are the downspouts in the flow-control tray?

2 What is the ratio of the total downspout flow area to the total tray area, in the flow-control tray?

The author is to be commended for a clear, precise, presentation.

Comment by F. W. Kirkpatrick, Jr.[24]

Various reforming catalysts are poisoned by nitrogen, sulphur, arsenic, water, glycol, and other compounds. The author's continuous regeneration eliminates difficulties with poisons whose actions are reversible. Is any problem, due to catalyst poisons whose actions are not reversible, anticipated?

Comment by Charles R. Patterson[25]

This paper gives information on new and interesting process equipment for reforming straight-run naphthas to effect upgrade in gasoline quality. Continuous catalyst regeneration is a feature of the equipment employing a recycle of flue gas containing an oxygen content below 2 per cent. The paper further states that in the lift line the combina- of a moving catalyst bed together with controlled oxygen content limits the peak temperature rise.

The reader must presume that the equipment operates with perfect control under all conditions. The question that arises (because automatic mechanical equipment is sometimes subject to erratic action and operational upsets do occur) is: How is combustion in the lift-line regenerator controlled when operational upsets occur?

Controlling the oxygen content is one method as presented in the paper. Another suggested method where the required pressure is available is to use steam injected into the lift-line regenerator at several strategic locations, or with the flue gas where it enters the lift line.

[23] Apparatus-Engineering, C. F. Braun & Company, Alhambra, Calif.

[24] Chemical-Engineering, C. F. Braun & Company, Alhambra, Calif.

[25] Standard Oil Company of California, El Segundo, Calif.

Author's Closure

To answer Mr. Hander's comments: catalyst make-up facilities are provided at the lift vessel at the bottom of the catalytic section. Catalyst addition is accomplished by the use of a small vessel attached to the lift vessel with block valves at both ends.

In reply to Mr. Helsel's questions: (1) The size and shape of the downspouts in the flow-control tray range from 8 to 12 in. diam cylinders depending upon the capacity of the unit. (2) The ratio of the total downspout-flow area to the total tray area in the flow-control tray ranges from 40 to 75 per cent and varies with size of the reactor.

Mr. Kirkpatrick's query deals with catalyst poisoning. The author anticipates no problem with respect to catalyst poisoning. The ability to refine both straight-run and high-sulphur stocks of all varieties of inferior crudes without catalyst poisoning is well established in so far as the cobalt-molybdate catalyst is concerned.

Replying to Mr. Patterson's comments: When operational upsets occur in the lift-line regenerator, the high-temperature alarm provided in the flue-gas line leaving the regenerator automatically shuts off the air compressor in case of an upset resulting in excessive temperatures. In the case of flue-gas circulation or blower failure, the air compressor is automatically shut off by an interlocking relay in the holding coil of the starter circuit.

C. Berg.[26]

Transportation Corps' Gas-Turbine Locomotive

Comment by S. D. Hage[27]

THE testing of the Transportation Corps' gas-turbine mechanical-drive locomotive[28] that has been done up to this writing has shown that this combination of turbine and transmission is not a particularly happy one. The transmission is designed for use with a torque converter, and the absence of this fluid member in the power train is undoubtedly responsible for a portion of the shift shock mentioned in the paper. The principal energy source for the shift shock is the second-stage, or power, turbine wheel's sudden deceleration when the transmission upshifts. For example, during the early testing an upshift from second gear to third gear resulted in a turbine-wheel deceleration from 23,700 rpm down to 10,200 rpm in a calculated time of 0.26 sec. The resulting energy release severely jolted the entire power train and resulted in the failure of the combining gear as reported by the author.

After installation of the redesigned combining gear, the transmission hydraulic pressure was reduced to approximately one half of its former value, and the operating technique was changed to include turbine throttle closure just prior to each shift so as to relieve the drive line of the gas torque during shifting. Judging from audible and tactile sensations, this has resulted in a substantial decrease in the shift shock. Whether or not the shifting stresses are now within safe limits, as they are calculated to be, will be determined only by further locomotive operation.

Locomotive Performance

The comments of observers concerning the smoothness and rapidity of locomotive acceleration under load are particularly interesting and gratifying to us. We have observed these characteristics in other motive-power applications of the turbine and feel that they will show to particular advantage in locomotive switching operations. This is borne out by the curve in Fig. 4 of the paper, which shows that the maximum tractive effort is available up to 6 mph.

Comment by R. T. Sawyer[29]

It must be remembered that the locomotive under discussion which is now in service is purely experimental. Not only is it the first gas-turbine locomotive in the world with mechanical drive, but also the first gas-turbine locomotive of any type owned by a military organization.

The Next Unit

Now that something is known of the performance of this first unit, the next to be built will have a speed limit between 50 and 60 mph, with more weight on the drivers, and greater power.

Some features of this new unit are known. It will have 50 per cent more weight on drivers, and an axle loading of 25,000 lb per axle. In the study which has been under way for some time, the following features have been developed:

[26] Union Oil Company of California, Wilmington, Calif. Mem. ASME.

[27] Chief Project Engineer, Gas Turbines, Boeing Airplane Company, Seattle, Wash. Assoc. Mem. ASME.

[28] "Development of the First Gas-Turbine Mechanical-Drive Locomotive," by E. L. Barlow, Jr., MECHANICAL ENGINEERING, vol. 77, February, 1955, pp. 133–136.

[29] Manager of Research, Alco Products, Inc., Schenectady, N. Y.: Technical Adviser to TRADCOM, Fort Eustis, Va. Mem. ASME.

1 The axles that assist in guiding will carry excess weight, if any, and allow weight on drivers to be adjusted correctly.

2 Two of these locomotives in multiple are equivalent to one locomotive with two 6-wheel swivel trucks with desired riding qualities and loading on drivers.

3 Side-rod drive will be used as the cheapest and surest way of driving one axle with another. With this system, counterbalance pound is negligible.

4 One half the weight of the main gearbox is hung on the axle like a traction motor, the other half spring-supported from the locomotive frame.

5 Improvement is needed in the system of gearing. The combining gearbox is required when using two turbines. It is the writer's opinion that two turbines are required for a mechanical-drive locomotive—for economy and to provide reserve power.

In certain limited applications, this type locomotive has a great opportunity for usefulness. Two such applications are as follows:

1 When the Army needs a locomotive in a tough spot where it is little used, it must be quiet, have no visible smoke, and require no maintenance facilities. The turbines must be light enough to be handled by two men and also easily flown from a maintenance depot.

2 If this locomotive is built specifically for arctic use, we find that turbine ratings can be increased and yet have the internal temperature so low the normal turbine life can be extended materially.

With lubricants selected for —65 F, there is nothing to freeze except the diesel fuel oil. With proper winterization, the diesel fuel oil can be ignited and, using the exhaust heat from the gas turbines, the entire locomotive can be sufficiently thawed out to get under way in $\frac{1}{2}$ hr. Even if the American railways never use a large quantity of gas-turbine locomotives, the Army has right now a program that is capable of producing one of the finest "Polar Bear" type of locomotives that just "loves cold weather."

Author's Closure

It is felt that two important factors concerning the development of this first gas-turbine mechanical-drive locomotive should be re-emphasized:

(1) This is an experimental locomotive and as such a great deal of pertinent information has been collected on the gas-turbine mechanical-drive combination.

(2) Standard "off-the-shelf" components were used in the construction of the locomotive in order to keep the cost as low as possible. In the author's opinion, progress on the accumulation of data has virtually reached the point where mutually compatible components could be designed and developed and successful performance expected.

Eight months have served to point out the gas-turbine mechanical-drive combination's three distinct advantages and two marked disadvantages:

(1) Excellent operating and performance characteristics, especially in yard operation where "stop-and-go" operations present stiff performance requirements.

(2) Simplicity and unit-replacement practicability from a maintenance viewpoint.

(3) Two turbines, when properly utilized, effectively reduce the over-all rate of fuel consumption in yard operation where extremely varied horsepower requirements are the rule.

(4) The gas turbine's high rate of fuel consumption is, of course, still the primary disadvantage. It is felt, however, that use of cheaper fuels and design improvements based on continued research will eventually nullify this deficiency.

(5) The design problems involved in adapting mechanical drive to gas turbines for locomotive use have not been completely resolved to date. However, with the information gained in the development and operation of this experimental unit, it is the author's opinion that the way is now in sight to the effective solutions to these problems.

E. L. Barlow, Jr.[30]

Designing Railway Passenger Cars[31]

Comment by F. K. Mitchell[32]

THIS presentation of the problem of railway passenger-car design and its solution is an outstanding contribution to the industry.

It is fitting that the author should emphasize the complications which have arisen in the past through lack of standardization in car design, floor plan, and the various parts required to make up a modern passenger car.

The impact, which the failure to evaluate this problem properly at the time when large quantities of so-called "post-war lightweight equipment" were being ordered, has been terrific and the realization of what it has cost the nation's railroads in additional maintenance and reduced utilization of equipment certainly should be adequate warning that a repetition of such a fiasco should never occur.

One only has to take a brief look at the passenger-traffic situation and the enormous passenger-traffic deficits now imposed on the principal passenger-carrying railroads of the country to realize that in the next attempt at the solution of this problem similar mistakes may create a situation where it will become too late for the railroads to eliminate these deficits and recapture the portion of the passenger business to which they, by reason of their position in the transportation field, are entitled.

It is well that the author has incorporated in his paper a review of the experience with early lightweight trains and the use of head-end power. Some of the observations with regard to early attempts to solve this same problem may be pertinent in permitting a logical solution now.

Air Conditioning

The author's comments on the effect of generator drag and the air-conditioning load should tend to awaken the industry to the fact that our present system surely belongs to "the horse-and-buggy days." We should be using modern built-in air-conditioning units with the power supply from outside which could be operated the year around without any maintenance whatever. This is a problem which the railroads and the air-conditioning-equipment producers should work out and put into effect without delay.

Heating Requirements. The author's comments with regard to the heating systems on our present trains are certainly pertinent. The maintenance cost of the present steam generator, steam-distribution system with its cumbersome and troublesome connectors between the cars is a source of expense, delays, and unsatisfactory service to the public. Certainly a far more economic and satisfactory system can be devised either through the use of electric heat from head-end source or a head-end heating arrangement utilizing waste heat from diesel-engine exhaust.

The matter of materials to be used in the so-called lightweight cars is one which should be given careful consideration, both from the point of view of strength and freedom from corrosion troubles. Stainless-steel and/or aluminum-alloy materials seem to offer the best

[30] Project Engineer, Transportation Research and Development Command, U. S. Army, Fort Eustis, Va.

[31] "Railway Passenger-Car Design—Realistic Goals," by T. C. Gray, MECHANICAL ENGINEERING, vol. 77, March, 1955, pp. 225–230.

[32] Assistant Vice-President, New York Central System, New York, N. Y. Fellow ASME.

solution for this problem. In combination with these materials, structural design may well follow the precepts of the airplane-industry's engineering.

In this connection, we cannot, of course, overlook the matter of safety and the strength requirement. While a studied review of the present AAR strength requirements may indicate that a reduction therein can be made and still offer perfect safety, we certainly should not be led into a situation which seems to exist on European lightweight trains, built without due regard to strength requirements.

Design Objectives

The author makes a plea for a passenger-train design which includes standard floor plans, low centers of gravity, low weight per seat, modernized air-conditioning equipment, excellent riding qualities, and minimized operation and maintenance costs without sacrifice of safety. The writer would like to emphasize further (*a*) that such a train should be made in units either of single or multiple-car design which could be added to or taken out of the train without the use of special equipment or necessity of shopping the train; (*b*) the desirability of a coupling arrangement, either between cars or groups of cars, which would be quickly operable and at the same time capable of maintaining train alignment in case of derailment or accident and so attached to the car or units that there is no possibility of jackknifing, telescoping, or similar troubles under any circumstances.

Comment by J. D. Loftis[33]

The author and his company are moving in the right direction when they aim at reducing the weight per passenger-car occupancy. The writer has been thinking in terms of 700–800 lb per seat for main-line high-speed passenger trains, and 500–600 lb per seat for suburban passenger trains. It is his conviction that this ultimately is possible and, in fact, probable. The next most important move is to reduce the cost commensurate with the reduction in weight.

The following suggestions are offered for consideration:

1 That builders progress as rapidly as possible along the lines presently pursued to get actual service tests of projected equipments.

2 That railroad and vendor suggestions be accepted and weighed against the ultimate benefit to be obtained, but that the goal of weight and cost reduction be the final criterion.

3 That present restrictive specifications be reviewed in the light of current conditions and recommendations for modifications consistent with safety be made without delay.

4 That the entire range of suppliers of equipment be investigated and where possible select specialties from production lines of household and industrial equipment so as to remove the restrictions now imposed by the use of specialized railroad equipment.

5 With the use of an a-c power supply, sealed compressors, and squirrel-cage motors, adopt the package unit wherever possible so that replacement will confine repairs to shops only. Let's stop the expensive on-the-road tinkering and patching.

6 Adopt as high train-line power-transmission voltage as possible so as to take full advantage of the weight saving of small copper transmission lines.

7 Make all couplings as nearly automatic as possible. The time and cost involved in making manual couplings is a very expensive factor.

8 Motive power, if possible, should be double end so as to eliminate the time and cost of turning.

9 Motive power should be designed with weight as much a factor as in car construction and should be packaged for shop attention only.

10 Let's get going and go after that part of the passenger transportation market where we have a definite advantage.

Comment by K. A. Browne[34]

The Train X development has been specifically mentioned by the author as a lightweight, articulated, single-axle car assembly. The writer would point out that Train X equipment has been designed to couple and uncouple for switching flexibility with less time and effort than consumed on conventional railroad cars. To his knowledge, this is the first design to permit flexibility of consist with a fully articulated construction. This characteristic is considered a basic requirement for any passenger car in widespread railway service.

Another unusual feature of Train X design is the spring suspension or, in other words, running-gear arrangement, which includes a pendulum action that inherently compensates for about half of the lateral acceleration resulting from unbalanced superelevation on curves. Heretofore, this was only done in part by the Hill "pendulum" cars, and never has been approached by any other truck spring system, with the possible exception of the "Goodyear Comet" on the N.Y.N.H.&H.R.R. Lowering of the center of gravity toward the rail is only incidental in the accomplishment of better ride for the passengers. The spring suspension system is dominant in this respect. With standard trucks, the ride is best high in the car body and gets worse the lower the passenger is located. Train X provides a solution to this problem and permits 40 per cent higher speed on curves for the same passenger-comfort level.

Comment by A. G. Dean[35]

With reference to cost of railway-car equipment, we can certainly concur with the author's statements regarding the high cost of custom building. Highly specialized cars are sometimes very useful and well worth the price, but general-purpose cars suffer from customizing.

"Car-builders' standards" are normally based on successful applications, usually on several railroads. Where applicable, their use takes advantage of engineering, manufacturing facilities, and shop experience which already has been paid for.

Customer inspection varies from inspection of first car at time of delivery only to a team of resident inspectors during the entire building program. We have yet to see any real difference affecting the appearance or serviceability of the finished product between the two systems.

Head-End Power

We question the unqualified approval of head-end or central auxiliary power plants. The economy potential of head-end power is indeed attractive and can be realized in some cases. In the case of unit trains or of cars regularly assigned to certain services, or on a railroad where all passenger equipment is provided with head-end power facilities, these economies can be realized. The flexibility of operation with other classes of train equipment not so equipped is seriously impaired. Obviously, there must be a source of head-end power in any train using even one such passenger car. Similarly, any existing equipment must be provided with a train line if it is to be intermingled with equipment designed for head-end power. It is difficult to evaluate the cost of such provisions dur-

[33] Assistant General Superintendent of Motive Power, Chicago, Rock Island & Pacific Railroad, Chicago, Ill. Mem. ASME.

[34] Director of Research, The Chesapeake & Ohio Railway Company, Cleveland, Ohio. Mem. ASME.

[35] Assistant Chief Engineer, The Budd Company, Railway Equipment Division, Philadelphia, Pa.

ing a transition period of change-over to head-end auxiliary power.

Even where inherently useful, we question the economies of electric heat. We are familiar with the annoyance of maintaining steam heat and understand the cost of such maintenance is high. Certainly electric heat would be convenient. The question is: Can we afford to pay for this convenience? For example, the paper indicates 80,000 lb of central power-plant equipment. About 50 kw per car is required during the heating season as contrasted to some 20 kw required during the cooling season. This 80,000 lb then could be reduced by some 60 per cent or 48,000 lb, if the requirements for heating were eliminated. Heat for this 16-car train could be provided by a 5300-lb steam generator. The average weight of water for a 4-hr run would be perhaps 4800 lb. The steam-heating system would be 6400 lb heavier than the electric system for the 16-car train. This totals to 16,500 lb for the steam heat as contrasted to 48,000 lb for the electric heat. Fuel is neglected because it is required in both cases, and, if anything, less fuel is required for the steam heat.

It also should be noticed that the weight figures in this paper are based on a 16-car train which just absorbs the capacity of the central power plant. If the same central power plant is used with an 8-car train, then the weight per car is 10,000 lb average, which is heavier than conventional equipment of axle generators, batteries, etc.

Horsepower Requirements

The horsepower requirements are stated by the author as drawbar horsepower and the curves shown mention "locomotive not included." This presentation is likely to be misleading. It is impossible to move a train without head-end or locomotive air and mechanical resistance, which in this paper is neglected. Even with self-propelled cars, which afford the minimum resistance chargeable to motive power, the 6-car train described will require about 80 per cent more horsepower at 100 mph than that shown.

While considering latest lightweight developments, the RDC should not be overlooked. As presently designed, it is most suitable for branch-line or other short-haul service. Recent studies have developed simple alterations, making it more suitable for mainline multiple-unit operation. Cost of train, including motive power, is less than anything published so far having equivalent performance.

When comparing weights of new developments to modern conventional equipment, the weight of the latter is usually taken as 115,000 to 130,000 lb. This is a realistic figure, but does not represent the best that the car builder can do by combining the best presently available service-proved equipment and features. Such a car can be built for about 75,000 lb with steam heat and head-end auxiliary power. The weight would be about 84,000 lb without head-end power. There is nothing speculative about these weights, the safety, or the riding comfort, as everything used in this design has been in service at least 5 years. No premium is paid for lightweight for any part, and development costs have been largely absorbed already. Consequently, impressive and immediate cost savings are available. This performance, which can be accurately forecast, appears to be comparable to what is being hoped for with the various radical approaches.

We believe low center of gravity has been overemphasized lately. While it is perhaps the simplest device to reduce roll, other economical methods are available making it unnecessary to sacrifice other desirable features to reach a low center of gravity. One of the outstanding features of dome cars, including the new full-length domes with center of gravity at about 65 in., is their excellent riding quality.

Comment by G. B. Hauser[36]

Attention is called to the fact that aluminum alloy 61S-T6 (now known as 6061-T6) cannot be used in passenger-car construction because of what is generally known as the "80 per cent rule" of the AAR Passenger Car Specification.

It is of interest to know that the Research Laboratories of the writer's company have worked up a case covering this alloy and temper, showing its physical and mechanical properties, its ductility, and reasons why the 80 per cent rule should not apply.

This case was transmitted to the Mechanical Division of the AAR several months ago and has been put on the docket of the Passenger Car Specification Committee. We have requested that consideration be given to approving the use of this alloy in spite of the fact that it does not meet the 80 per cent rule. We did not request a change in the specifications.

Approval of this alloy it is believed would give the designer and builder of passenger cars a most effective tool for reducing the weight of passenger equipment safely.

[36] Chief Railroad Engineer, Development Division, Aluminum Company of America, New Kensington, Pa. Mem. ASME.

Author's Closure

The author was most fortunate in the selection of such an eminently qualified discussion panel and is most appreciative of the remarks made. Both Messrs. Mitchell and Loftis, while being in general agreement with the author's observations, added materially to the paper's value by developing and enlarging many of its points. Of great significance was the apparent unanimity of thought and purpose between representatives of both builders and customers on the matter of solving rail-passenger transportation ills.

Mr. Browne's amplification with reference to the switching flexibility of Train X with an articulated construction is of real value. His remarks on the novel suspension employed with Train X are also propitious and should serve as an answer to Mr. Dean's comments on center of gravity.

The author fully agrees with Mr. Dean that good construction, appearance, and serviceability of our cars are not direct functions of the complexity of the customer's inspection. Regarding Mr. Dean's further remarks, we would question the situation being "seriously" impaired during a transition period to allow the very desirable use of alternating current and "off-the-shelf large-volume electrical equipment." Moreover, and as brought out in the paper, the rewards are well worth while. Obviously, front-end (locomotive-placed) auxiliary potential is more desirable for trains of eight cars or less. However, on such conventional 16-car trains, as described in the paper, a central-power car as proposed would (1) effect real economies, (2) allow the use of presently available propulsion power, (3) make available more of the propulsion potential for accelerations, (4) allow the use of conventional cars forward of the specially equipped cars, and (5) greatly simplify and lower costs of the simplified passenger car to be used with the auxiliary power-car train.

Mr. Dean does agree that electric heat would be convenient but questions our being able to afford it. The author's comparison of a conventional 548 passenger "luxury" train versus a comparable consist and utilizing the central auxiliary power car reflects a net saving of train weight of 172 tons. This we know is a very conservative figure. The 80,200 lb mentioned is net weight saving of electrical equipment for the train and is not weight of central-power-plant equipment. Two 400-kw diesel-generator sets are provided which assures nearly 100 per cent stand-by the great majority of operating time. Actually, the electric heat

installation weight including prorated weight of one 400-kw diesel-generator set is about an offset with a steam installation. The differential in weight of the other diesel generator versus the steam generator and water is not of great magnitude. Obviously, weight per car would be slightly higher as cars are reduced in number but not nearly in the order suggested.

Mr. Dean questions the reflected power requirements. As stated in the paper, the related curves were based essentially upon the Davis formula which includes running resistance. A *balancing speed* of approximately 100 mph is indicated. The 1000 DBHP mentioned is that needed for the cars only to reach a balancing speed of 100 mph. For total train and with desired acceleration, more propulsion power would be required.

The Budd Company has made a most worth-while contribution in their rail diesel car. For branch line and feeder service this unit certainly fills a much wanted need. However, it cannot make full use of the inherent advantage of centralizing propulsion and auxiliary potential in one "basket" with resultant minimum cost, weight, price, operation, and maintenance of trains of some length.

The 84,000-lb potential weight of a near-conventional coach without head-end power mentioned by Mr. Dean is realistic. However, the train trailing weight would still be nearly twice as great as the weight of a comparable train X passenger consist.

It is hoped that early affirmative action will be taken on the approval of the aluminum alloy 61S-T6 by the Mechanical Division of AAR as discussed by Mr. Hauser.

T. C. Gray.[27]

[27] Vice-President, Engineering Pullman-Standard Car Manufacturing Co., Chicago, Ill. Mem. ASME.

Reviews of Books

And Notes on Books Received in Engineering Societies Library

Steam

STEAM: Its generation and use. The Babcock & Wilcox Co., New York, N. Y., 37th edition, 1955. Cloth, 8¼ × 11 in., figs, tables, 29 sections of varying number of pages, appendixes, index, $10.

Reviewed by Andrey A. Potter[1]

"STEAM" first appeared in 1879, 12 years after the formation in 1867 of the partnership between George H. Babcock and Stephen Wilcox, and two years before the present Babcock & Wilcox Company was incorporated.

In 1901 my teacher of steam engineering at the Massachusetts Institute of Technology, Edward F. Miller, called the attention of his class to a practical treatise on steam and steam equipment and presented several of his students with copies of this book. Accordingly, I was pleased to have been requested by ASME to review the thirty-seventh edition of this treatise. As one would expect, the several editions of "Steam" are a record of the progress made in the design of steam-generating equipment and the related auxiliary equipment. Thus the thirty-seventh edition of "Steam" gives special attention to metallurgy and properties of materials, the cyclone furnace, nuclear power, and to research and development.

In the introduction one is interested to learn that while some knowledge of the use of the expansion force of the vapor of water existed before 150 B.C., the first treatise bearing on steam generation appeared in 1571, and the first proposal of a steam engine was made by Edward Somerset in 1663. A patent covering an improvement in Savery's engine, taken out by William Blakey in 1766, included a design of the first water-tube boiler. Stephen Wilcox, in 1856, was the first to use water tubes connecting water spaces at the front and rear with a steam space above. It is interesting that the criteria for a perfect steam boiler, formulated by Stephen Wilcox in 1875, which appeared in the first edition of "Steam," do not differ materially from the requirements of today. Water-tube boilers, installed in the first electric-power plants at the Brush Electric Company's Philadelphia, Pa., plant in 1881, and at the Pearl Street plant in New York, N. Y., in 1882, have remained the steam-generating equipment for steam-electric power stations. From about 1900 to the period of World War I, steam pressures and temperatures in electric-central stations gradually increased. By 1914, the maximum pressures rose to 550 psi and 725 F, and in 1925 to 1200 psi and 720 F. Now a plant is designed to operate above the critical pressure at 4500 psi and 1150 F.

"Steam" devotes a chapter to coal as the present major source of heat energy for stationary plants, and a chapter to other sources of energy including petroleum, natural gas, and fuels derived from coal. Both chapters include up-to-date information about these fuels. Principles of combustion, draft-producing equipment, temperature measurement, boilers, economizers, air heaters, superheaters, preheaters, and coal-burning equipment are well treated. The book also treats well and accurately heat transfer, fluid dynamics, fuel ash, steam generation, and energy cycles. Up-to-date information is included on coal preparation and storage and utilization of waste heat. Separate chapters are devoted to selection, installation, and care of steam-generating equipment, methods of manufacture, and marine applications.

The Babcock & Wilcox Company, through the thirty-seventh edition of "Steam," has made a distinctive contribution during a period of 76 years to the literature on steam power. This edition should prove of special interest to engineering teachers and students, as well as to those concerned with power generation.

[1] Dean of Engineering Emeritus, Purdue University; President, Bituminous Coal Research, Inc. Hon. Mem. ASME.

Supervision

A THOUSAND QUESTIONS ON SUPERVISION IN PHILIPPINE GOVERNMENT. By Dan M. Braum. Institute of Public Administration, University of the Philippines, Manila, P. I., 1954. Paper, 5½ × 9 in., xiii and 210 pp., price not given.

Reviewed by Lillian M. Gilbreth[2]

DANIEL M. BRAUM is a member of The

[2] President, Gilbreth, Inc., Montclair, N. J. Hon. Mem. ASME.

Library Services

ENGINEERING Societies Library books may be borrowed by mail by ASME Members for a small handling charge. The Library also prepares bibliographies, maintains search and photostat services, and can provide microfilm copies of any items in its collection. Address inquiries to Ralph H. Phelps, Director, Engineering Societies Library, 29 West 39th St., New York 18, N. Y.

American Society of Mechanical Engineers and was for years on the Management Committee. With a background of government service in the Department of Agriculture, he has represented American management in agriculture at several CIOS[3] congresses.

A few years ago he undertook an FOA assignment in the Philippines and joined a University of Michigan team assigned to work with the University of the Philippines in Manila.

There he organized a course for supervisors in government service, based on the questioning method. It was a pioneer project in this field of application, which developed with speed and effectiveness under his direction. The participants in the courses turned in questions daily that covered problems in their own work lines.

Fortunately, these questions were preserved after they had been made the subject of discussions. More than a thousand of them were collected.

In spite of a busy and demanding life in a tropical climate, Daniel and Roberta, his wife, were persuaded to organize the questions, answer them, and present the result in a book that is unique, challenging, and important.

We read in it of problems that in many ways are like our own—technical problems and those in the field of human relations. We note also differences from our own problems, based on differences in our history, which make it clear that no country can safely copy the practices of another. Each country must find, state, and solve its own problems, using other countries' experiences as resources.

Besides an original and worth-while record of a project providing such resources to a country as ready to give, take, and share as the Philippines has proved to be, this book exemplifies the splendid type of service that a small family team—which is a part of a larger USA team—can give.

[3] Comite International de l'Organization Scientifique.

It will be read at first, perhaps, as case material illustrating American contributions to other countries, then recognized as furnishing techniques and data of human relations that can be used here in the United States. Finally, it will be reread as a human document, illustrating a type of activity which deserves the stamp of approval: "Of this, we can be proud."

Books Received in Library...

ASTM STANDARDS ON WOOD, WOOD PRESERVATIVES, AND RELATED MATERIALS. American Society for Testing Materials, Philadelphia, Pa., 1954. 358 p., 9 × 6 in., paper. $3.75; members $2.80. These standards cover evaluation of mechanical and physical properties, methods for chemical analysis, structural grading and specifications of wood and timbers, fire tests of building materials, and specifications and tests for preservatives.

ALUMINUM PAINT AND POWDER. By Junius David Edwards and Robert I. Wray. Reinhold Publishing Corporation, New York, N. Y., third edition, 1955. 219 p., $9^1/_4$ × 6 in., bound. $4.50. Detailed information is given on the manufacture, properties, testing, and uses of aluminum powder, and on the composition, properties, and applications of aluminum paint. Uses of paint discussed include metal protection; painting of oil tanks, structures, etc.; and the protection of wood. Powder applications treated include uses on aircraft fabrics; in plastics, powder metallurgy, and aerated concrete; and as a lubricant. A list of references follows each chapter.

BELASTUNGSGRENZEN BEI GERAD- UND SCHRÄGVERZAHNTEN STIRNRÄDERN. (Schriftenreihe Antriebselemente, No. 5.) By Constantin Weber and Werner Thuss. Friedr. Vieweg & Sohn, Braunschweig, Germany, second edition, 1954. 132 p., $11^5/_8$ × $8^1/_8$ in., paper. 16.80 DM. The two reports included in this publication present the mathematical fundamentals for the determination of various load limits of straight and helical gears, and discuss changes in tooth dimensions and operating conditions which favorably affect the load limit.

BETTER TOOL CRIBS. By William Raisglid. Industrial Press, New York, N. Y., 1954. 152 p., $9^1/_4$ × 6 in., bound $4. A step-by-step guide to the organization and management of tool cribs to insure maximum speed in supplying tools, materials, and parts, and maximum safety in storage. Twelve concise chapters are devoted to various aspects of the subject, including control systems, marking systems, and cribs for large plants.

CONVERSION FACTORS AND TABLES. By O. T. Zimmerman and Irvin Lavine. Industrial Research Service, Inc., Dover, N. H., second edition, 1955. 501 p., $6^1/_4$ × $4^1/_4$ in., bound. $5. This pocket-size handbook includes an alphabetical list of United States, British, and metric units with conversion factors; separate lists of foreign units; tables of conversion data covering pressure, viscosity, hardness, wire gages, etc.; physical constants; and foreign monetary equivalents.

COURS DE RÉSISTANCE DES MATÉRIAUX. By J. Courbon. Dunod, Paris, France, 1955. 782 p., $9^1/_2$ × $6^1/_4$ in., bound. 7400 Fr. An introduction to strengrh of materials for practicing engineers as well as for students. The major part of the book is devoted to the theory of both statically determinate and statically indeterminate beams and arches approached by various methods. Problems of elastic stability, thin plates, slabs, and suspension bridges are considered.

CYCLES AND PERFORMANCE ESTIMATION. (Gas-Turbine Series, vol. 1.) By James Hodge. Academic Press, Inc., New York, N. Y., 1955. 329 p., 10 × $6^1/_4$ in., bound. $9. This first volume in a new series on current gas-turbine theory and practice sets out the basic principles for assessing gas-turbine performance. The greater part of the book is devoted to the analysis of idealized cycles and to the presentation of performance data, mainly in graph form, for a wide selection of actual cycles such as are used in shaft-power generating plants, aircraft engines, blast-furnace blowing, and other applications. The estimation of performance of turbines under conditions other than those for which designed is also treated.

DAVISON'S RAYON, SILK, AND SYNTHETIC TEXTILE, 1955. Davison Publishing Company, Ridgewood, N. J., sixtieth edition, 1955. 500 p., $9^1/_4$ × $6^1/_2$ in., bound. $8. The main part of this annual directory is comprised of a separate geographical list of manufacturers, and another of dyers, printers, and finishers, both with indexes classified by products. Also included are lists of commission merchants, brokers, importers, New York offices of mills, converters, etc., and a technical section giving statistics of fiber production, yarn tables, and an outline of test methods for fibers. An alphabetical mill index is provided.

DIMENSIONS AND TOLERANCES FOR MASS PRODUCTION. By Earle Buckingham. Industrial Press, New York, N. Y., 1954. 164 p., $11^1/_4$ × $8^3/_4$ in., bound. $8. The author discusses the problem of dimensioning with tolerances in relation to production design, tool design, gage design, production, and inspection, and suggests methods and practices that would eliminate uncertainties in present practice. He also shows how limiting dimensions on detail drawings control conditions of bulk or size, form, position, assembly, operation, or functioning, and how methods for specifying tolerances may be different for each of these conditions. Worked-out examples illustrate the discussion.

DIRECTORY OF COMMERCIAL AND COLLEGE TESTING LABORATORIES. American Society for Testing Materials, Philadelphia, Pa., 1955. 39 p., $10^1/_4$ × $7^3/_4$ in., paper. $1. Information is given concerning 278 commercial and 86 college laboratories which will test commodities for acceptance or for other purposes in accordance with standard specifications. The arrangement is alphabetical, both by name and by geographical location, with a system of numbers and letters used to indicate types of commodities tested and the nature of tests. This compilation supersedes Miscellaneous Publication M187 of the National Bureau of Standards.

DYNAMICS OF MACHINERY. By A. R. Holowenko. John Wiley & Sons, Inc., New York, N. Y., 1955. 464 p., $9^1/_4$ × 6 in., bound. $7.50. A textbook thoroughly covering basic principles, illustrated by a wide variety of problems. The slider-crank mechanism is used extensively for velocity, acceleration, force, and dynamic analysis, and chapters are included on balancing of engines, vibrations in shafts, and gyroscopes. Both analytical and graphical developments

are presented, and free-body diagrams are used throughout the book.

English-German and German-English Dictionary for the Iron and Steel Industry. By Eduard L. Köhler. Springer-Verlag, Vienna, Austria, 1955. 162 p., $8^1/_4 \times 6$ in., bound. $6.65. In order to include all the divisions of the iron and steel industry the compiler has included only directly pertinent terms, omitting terms from related fields such as plant economy and machining. A special effort has been made to cover the terminology of the most recent developments, and equivalents are frequently explained by simple definitions indicating the field of usage. American spelling is adhered to throughout.

Experimental Mechanics and Properties of Materials. By Carl W. Muhlenbruch. D. Van Nostrand Company, Inc., New York, N. Y., second edition, 1955. 243 p., $9^1/_4 \times 6$ in., bound. $3. This revision of "Testing of Engineering Materials," 1944, contains twenty laboratory experiments ranging from the stress-strain diagram for mild steel to verification of the moment-area method of determining deflections of beams. Emphasis is on applications of results rather than on details of procedures, with the aim of providing a fundamental understanding of real materials as a prerequisite to good design.

Gas Turbine Principles and Practice. Edited by Sir Harold Roxbee Cox. D. Van Nostrand Company, Inc., New York, N. Y., 1955. Various paging, $8^3/_4 \times 5^3/_4$ in., bound. $12.50. A comprehensive survey of thermodynamic principles, constructional features, and operating characteristics of the important types of gas turbines. The thirty sections, prepared by twenty-four specialists, cover a wide range of subjects including compressors, axial and radial turbines, materials, fuels, heat exchangers, and special problems encountered in the use of gas turbines in aircraft, marine engineering, transport, and industry. The book is intended for engineers, designers, and students specializing in gas-turbine engineering.

Gas Turbines for Aircraft. By Ivan H. Driggs and Otis E. Lancaster. Ronald Press Company, New York, N. Y., 1955. 349 p., $9^1/_4 \times 6^1/_4$ in., bound. $10. The main subjects treated are cycle analysis; flow of gases through channels and ducts; flow through compressor and turbine; combustion; matching compressor and turbine; control problems; and aircraft-performance analysis. Basic thermodynamics are also covered, and the concluding chapter reviews improvements made in gas-turbine engines developed during recent years.

Gestaltfestigkeit. Versuche mit Schwingern. By S. Berg. Deutscher Ingenieur-Verlag, Düsseldorf, Germany, 1952. 484 p., $9^3/_4 \times 7$ in., bound. 69 DM. Vibration testing of machine elements is thoroughly covered in this well-illustrated volume. The three major sections deal with the following: Methods and equipment; applications and results of tests on a wide variety of machine parts; an outline of the theory of vibration. A bibliography of some 450 items is included.

Grundzüge der Zerspanungslehre. Volume 1: Einschneidige Zerspanung. By Max Kronenberg. Springer-Verlag, Berlin, Germany, second edition, 1954. 430 p., $9^1/_4 \times 6^1/_4$ in., bound. 48 DM. This standard work on metal cutting has been considerably enlarged and revised from the earlier edition. The two major sections cover, respectively, basic metal-cutting theory and its application to the construction and operation of machine tools. Only single-point cutting is covered in this first volume. Vol. 2 is to deal with drilling, milling, etc., and their relationships to the turning operation.

Heating, Ventilating, Air Conditioning Guide, 1955. American Society of Heating and Air-Conditioning Engineers, Inc., New York, N. Y., volume 33, 1955. 1680 p., $9^1/_4 \times 6$ in., bound. $12. Changes in codes and standards, new methods in product design, and improved engineering practices have been incorporated in the revision. Arrangement and coverage remain unchanged, with a wide range of topics treated under the following broad headings: Fundamentals, human reactions, heating and cooling loads, combustion and consumption of fuels, systems and equipment, special systems, and instruments and codes.

Helical Spring Tables. By John D. Gayer and Paul H. Stone, Jr. Industrial Press, New York, N. Y., 1955. Various paging, $9^1/_4 \times 6$ in., bound. $5. Two sets of tables, one of compression springs arranged by coil diameters of from $^1/_8$ in. to 4 in., and one of tension springs $^1/_8$ in. to 2 in., similarly arranged. Basic design data are given to permit selection of springs for special requirements and as a starting point in designing to exacting specifications. Factors for modifying the tabulated data and instructions and examples for using the tables are included.

L'Instabilité en Mécanique. By Y. Rocard. Masson et Cie, Paris, France, 1954. 239 p., $9 \times 5^1/_2$ in., paper. 1200 Fr. The three sections of this treatise on dynamic instability deal with the following major topics: A general treatment of self-excited oscillations, including application to the problems of a motor vehicle in motion; instability in suspension bridges, with a detailed analysis of the Tacoma Bridge case; a practical treatment of airplane wing flutter, longitudinal stability, and related matters. The major interest is in the common factors underlying all these conditions.

Jahrbuch der Oberflächentechnik, 1955. Edited by W. Wiederholt. Metall-Verlag, Berlin, Germany, eleventh edition. 904 p., $5^7/_8 \times 4^1/_4$ in., bound. 15 DM. An annual publication which aims to present the latest information available in the technical and patent literature of Germany and other countries on the mechanical, chemical, and electrochemical treatment of metal surfaces. In addition to survey articles by specialists, the book contains data tables, an extensive classified bibliography for 1953–1954, standards, a list of trade journals, etc.

Mécanique-Physique Générale. By Maurice Denis-Papin. Dunod, Paris, France, fifth edition, 1955. 253 p., 64 p., 6×4 in., bound. 480 Fr. This pocket-size volume contains formulas, definitions, diagrams, conversion tables, and other specific data for the basic fields of mechanics, general physics, and electricity, including separate sections for kinematics, gravitation, thermodynamics, fluid mechanics, and vibration.

Motion and Time Study. By Marvin E. Mundel. Prentice-Hall, Inc., New York, N. Y., second edition, 1955. 575 p., $9^1/_4 \times 6^1/_4$ in., bound. $9.35. A systematic treatment of modern procedures and techniques for the development of improved work methods and the measurement of human performance. Cases chosen from many different industries and types of works are used to illustrate the discussion of process charts, multiple-activity analysis, predetermined time standards, and the related subjects covered. Six new chapters have been added to this edition.

Nuclear Physics. By Alex E. S. Green. McGraw-Hill Book Company, Inc., New York, N. Y., 1955. 535 p., $9^1/_4 \times 6$ in., bound. $9. Primarily concerned with theories and experiments relating to the characteristics, behavior, and internal structure of nuclei, this comprehensive introduction to the field reviews the background material of atomic physics and discusses the following major topics: Instruments and methods; experimental results and their interpretation; systematics and semi-empirical theory; and nuclear theory. A chapter covering the essentials of quantum mechanics is included to provide a basis for understanding the chapters on theory.

An Outline of Atomic Physics. By Oswald H. Blackwood and others. John Wiley & Sons, Inc., New York, N. Y., third edition, 1955. 501 p., $9^1/_4 \times 6$ in., bound. $7.50. Intended for readers with a knowledge of elementary physics, this book deals with the structure of atoms and molecules and the nature of radiation as revealed by modern physical science. Certain topics in the new physics—for example, nuclear fission and cosmic rays—are treated, as well as are the more-established subjects such as the periodic system, the Bohr model of the atom, etc.

Plant and Process Ventilation. By W. C. L. Hemeon. Industrial Press, New York, N. Y., 1955. 437 p., $9^1/_4 \times 6$ in., bound. $9. The emphasis in this book is on methods for analyzing factory-ventilation problems and the dynamics of the air-pollution process to determine quantities of ventilating air needed and the best methods for channeling air into the space in question. Subjects covered include behavior of contaminants in air; ventilation for bulk-materials-handling systems and hot processes; design of duct systems, exhaust systems, and related equipment. Tabular or graphical summaries are provided to meet the needs of the plant engineer.

Praktische Getriebelehre. Volume 2: Die Keilkette. By Kurt Rauh. Springer-Verlag, Berlin, Germany, second edition, 1954. 172 p., 128 p., $10 \times 6^3/_4$ in., bound. 43.50 DM. A large assortment of mechanisms working on the basic principle of the wedge or inclined plane is discussed from the point of view of the practical designer of machinery. In addition to a general survey of possible mechanisms, the problems of interrelations, transformations, effects of dimension change, and applications are considered in detail. The coverage has been expanded, and the now more than 800 illustrations are collected at the back of the volume.

Symposium on Testing Adhesives for Durability and Permanence. (Special technical publication No. 138.) American Society for Testing Materials, Philadelphia, Pa., 1953. 60 p., 9×6 in., paper. $1.75. The five papers included deal with effect of specimen structure in tests of wood adhesives; testing glass adhesives; investigations of durability of woodworking adhesives; nondestructive methods; and field and laboratory tests of adhesives in the rubber-resins systems.

Testing and Inspection of Engineering Materials. By Harmer E. Davis, George Earl Troxell and Clement T. Wiskocil. McGraw-Hill Book Company, New York, N. Y., second edition, 1955. 431 p., $9^1/_4 \times 6^1/_4$ in., bound. $6.50. The first section of this book, a general treatment of principles with special reference to mechanical properties of materials, covers measurement of load, length, and deformation, inspection, and the following tests: static tension and compression; shear

and bending; hardness and impact; fatigue and creep of metals; and nondestructive testing. The second section describes methods of conducting tests using the most ordinary apparatus. Among the new subjects treated in this edition are ultrasonic testing, low-temperature impact tests, and developments in testing equipment.

THERMODYNAMICS. By Ray L. Sweigert and Mario J. Goglia. Ronald Press Company, New York, N. Y., 1955. 355 p., $9^1/_4 \times 6^1/_4$ in., bound. $6.50. The intent of the authors has been to provide a text which will give junior engineering students a clear grasp of fundamentals by proceeding from information already known to real examples, and by thoroughly discussing each concept and its physical significance. The text opens with a presentation of the ideas necessary for an understanding of the laws of thermodynamics, proceeds to applications through a study of selected topics in heat-power engineering, and concludes with a chapter on engineering processes which illustrate the use of fundamentals.

THERMODYNAMICS REFRESHER FOR PROFESSIONAL ENGINEERS' LICENSE. By John D. Constance, 625 Hudson Terrace, Cliffside Park, N. J., second edition, 1955. Various paging, $8^1/_2 \times 11$ in., paper. $3.25. Changes made in this edition consist chiefly of additional problems on processes of gases, internal-combustion engines, and a few other topics; a new problem section on reheat and regenerative cycles; a chart to determine specific volume of steam, given pressure, and enthalpy; and minor revisions and corrections in the text. The problems have been selected from examinations given in several states.

DIE TRAGFÄHIGKEIT DER ZAHNRÄDER. By A. K. Thomas. Carl Hanser Verlag, Munich, Germany, second edition, 1954. 182 p., $8^1/_4 \times 6$ in., bound. 14.80 DM. This book, based on practical needs and experiences in the drafting room, is useful in the calculation of individual gears and gear mechanisms. The determination of load capacity of spur, bevel, worm, and helical gears is treated in detail, and procedures using geometrical analysis are discussed. Minor changes in the text and some additions to the bibliography have been made in the revised edition.

TURBOBLOWERS. By A. J. Stepanoff. John Wiley & Sons, Inc., New York, N. Y., 1955. 377 p., $9^1/_4 \times 6$ in., bound. $8. This book deals with the hydrodynamic and thermodynamic aspects of turboblower design, and with the present state of the art of building turbocompressors in this country and abroad. Among the special features are the theoretical treatment of the compressor impeller based on a single pattern of flow, and the axial-flow compressor-design method based on the actual fluid-deflection angles rather than airfoil coefficients.

DIE VORBEREITUNG DES HOCHOFENMÖLLERS. By W. Luyken. Springer-Verlag, Berlin, Germany, 1953. 377 p., $9^3/_8 \times 6^3/_8$ in., bound. 37.50 DM. A general treatment of the preparation of the blast-furnace charge: ore preparation, ore dressing, briquetting, sintering, etc. The economic aspects are dealt with and considerable space is also devoted to the production of blast-furnace coke. Primarily a text for students of ferrous metallurgy, the book can also serve as a reference work for practicing metallurgists.

DAS WÄRMETECHNISCHE MESSWESEN IN DAMPFKRAFTWERKEN UND INDUSTRIEBETRIEBEN. By Arthur Ketnath. Springer-Verlag, Berlin, Germany, 1954. 222 p., $9^1/_4 \times 6^1/_2$ in., bound. 25.50 DM. The main emphasis in this book on heat measurements is on the planning and design of supervisory control installations in steam-power plants and industrial steam-generating units, the descriptions of heat-measuring devices and techniques being limited to this approach. An appendix contains a tabular index to the control points and instruments indicated in the schematic diagrams throughout the text.

WATER SUPPLY ENGINEERING. By Harold E. Babbitt and James J. Doland. McGraw-Hill Book Company, Inc., New York, N. Y., fifth edition, 1955. 608 p., $9^1/_4 \times 6^1/_4$ in., bound. $8.50. This standard textbook has been revised to include information on the latest accepted practices, and has been broadened in scope by the inclusion of material on industrial water supplies. Emphasizing design throughout, the coverage includes estimation of water usage; determination of water availability; fundamentals of hydraulics; materials of construction; design and maintenance of pumping stations and distribution systems; and methods of water purification. Numerous references to source material are given in order to make the book useful to practicing engineers and advanced students.

WÖRTERBUCH DER KOKEREITECHNIK. Edited by Didier-Kogag-Hinselmann Gmbh. Vulkan-Verlag Dr. W. Classen, Essen, Germany, 1954. 329 p., $7^1/_4 \times 5$ in., bound. 26 DM. A dictionary of coke-oven practice in two sections: German-English and English-German. Each section contains four parts: technical terms; commercial terms; conversion tables for weights and measures; abbreviations. A separate appendix contains conversational expressions from English to German.

ASME BOILER AND PRESSURE VESSEL CODE

Interpretations

THE Boiler and Pressure Vessel Committee meets monthly to consider "Cases" where users have found difficulty in interpreting the Code. These pass through the following procedure: (1) Inquiries are submitted by letter to the Secretary of the Boiler and Pressure Vessel Committee, ASME, 29 West 39th street, New York 18, N. Y.; (2) Copies are distributed to Committee members for study; (3) At the next Committee meeting interpretations are formulated to be submitted to the ASME Board on Codes and Standards, authorized by the Council of the Society to pass upon them; (4) They are submitted to the Board for action; (5) Those which are approved are sent to the inquirers and are published in MECHANICAL ENGINEERING.

(The following Case Interpretations were formulated at the Committee meeting April 29, 1955, and approved by the Board on June 16, 1955.)

CASE NO. 1204

(Special Ruling)

Inquiry: Is it permissible in welded construction conforming to the requirements of Section VIII of the Code to use quenched and tempered steel plate and forgings conforming to the requirements of the following specification:

(1) *Scope.* This specification covers alloy-steel plates of firebox quality and alloy-steel forgings intended particularly for use in welded pressure vessels.

(2) *General Conditions for Delivery.* Material furnished under this specification shall conform to the applicable requirements of the current edition of the Tentative Specification for General Requirements for Delivery of Rolled Steel Plates of Flange and Firebox Qualities (ASTM Designation: A 20), except as herein modified.

(3) *Process.* The steel shall be made by either or both of the following processes: open-hearth or electric-furnace.

(4) *Heat-Treatment.* The material shall be treated by the material manufacturer to produce the tensile requirements of Table II by heating to not less than 1650 F, quenching in water between 50 F and 100 F, and tempering to not less than 1150 F with a holding time of one hour per inch of thickness, but in no case less than one-half hour.

(5) *Chemical Composition.* The steel shall conform to the chemical requirements prescribed in Table 1.

TABLE 1 CHEMICAL REQUIREMENTS, PER CENT

Carbon	0.10/0.20
Manganese	0.60/1.00
Phosphorus, max	0.035
Sulfur, max	0.040
Silicon	0.15/0.35
Nickel	0.70/1.00
Chromium	0.40/0.80
Molybdenum	0.40/0.60
Vanadium	0.03/0.10
Copper	0.15/0.50
Boron	0.002/0.006

If the material is subjected to check analysis, the AISI standard permissible variations apply.

(6) *Tensile Properties.* The material as represented by the tension test specimens shall conform to the requirements as to tensile properties prescribed in Table 2.

TABLE 2 TENSILE REQUIREMENTS

Tensile strength, psi, min	105,000
Yield strength, psi, min	90,000
Elongation in 2 in., min, per cent	17

(7) *Bending Properties.* The bend test specimen shall stand being bent cold (room temperature) through 180 deg without cracking on the outside of the bent portion to an inside diameter which shall have the relation to the thickness of the specimen prescribed in Table 3. When the test is made on a specimen reduced in thickness, the rolled surface shall be on the outer curve of the bend.

TABLE 3 BEND DIAMETERS

Thickness of material, in.	Ratio of bend diameter to thickness of specimen
1/2 in. to 1 in., incl.	2
Over 1 in. to 2 in., incl.	3

(8) *Test Specimens.* The test specimens shall be prepared from the material in its heat-treated condition, or from full-thickness samples similarly and simultaneously treated.

(9) *Number of Tests for Plate.* One tension test longitudinal from the bottom, one tension test longitudinal from the top, and one bend test transverse from the top shall be made from each plate as heat-treated. One homogeneity test shall be made from each plate as rolled.

NOTE: The term "plate as rolled" used here refers to the unit plate rolled from a slab or directly from an ingot in its relation to the location and number of specimens, not to its condition.

(10) *Number of Tests for Forgings and Formed Parts.* One tension and one bend specimen shall be made of each heat of material included in any one heat-treatment lot.

Reply: It is the opinion of the Committee that the material specified in the Inquiry may be used in the construction of welded pressure vessels under the rules of Section VIII of the Code provided the following additional requirements are complied with:

(1) The maximum thickness of shell and head plates shall be 2 in.

(2) The maximum operating temperature shall not exceed 650 F.

(3) The requirements of Par. UG-84 shall be met for vessels that are to operate at temperatures below —20 F.

(4) The maximum allowable stress value for use in Table UCS-23 shall be 26,250 psi.

(5) Shell plates shall not be heated for forming to a temperature higher than 1100 F. Other parts including heads that are heated for forming to temperatures over 1100 F shall be heat-treated by the manufacturer of the head or part. Forgings shall be heat-treated by the manufacturer of the forging. Test specimens prepared from full-thickness material in its final heat-treated condition, or from full-thickness samples similarly and simultaneously treated, shall be taken from any pressure parts that have been heat-treated above 1100 F after forming.

(6) When the shell or head thickness exceeds 0.50 in., the finished vessel shall be stress-relieved as provided in Par. UCS-56(c). The stress-relieving temperature shall be between 1000 F and 1100 F (at least 50 F below the minimum tempering temperature).

CAUTIONARY NOTE: Filler metal deposited by nickel-molybdenum-vanadium type of electrodes can become embrittled at the above stress-relieving temperature.

(7) Double-welded butt joints shall be examined radiographically for their full length as prescribed in Par. UW-51.

(8) Welds not fully radiographed, including welds for attaching nonpressure parts, shall be examined after the hydrostatic test by the magnetic-particle method.

(9) The qualification of the welding procedure and the welders shall conform to the requirements of Section IX, except that the radius of the mandrel used in the guided bend tests may be 1 1/4 in. instead of 3/4 in. A separate welding procedure shall be made for this material.

(10) All main welded joints including welds for nozzle attachment shall be of the double-welded butt type.

CASE No. 1205

(*Special Ruling*)

Inquiry: Under what conditions may the carbon and alloy steel forgings of ASTM Specification A 372-53T be used in the construction of special integrally forged unfired pressure vessels and be stamped with the Code symbol? May working stresses of one third of the minimum specified tensile strength be used for storage vessels in non-corrosive service?

Reply: It is the opinion of the Committee that forgings complying with ASTM Specification A 372-53T may be used in the construction of seamless unfired pressure vessels under the rules of Section VIII provided the following additional requirements are met, and when so constructed the vessels may be stamped with the Code symbol.

(1) The maximum inside diameter of the shell is 24 in.

(2) The design temperature of the vessel is between —20 F and 150 F.

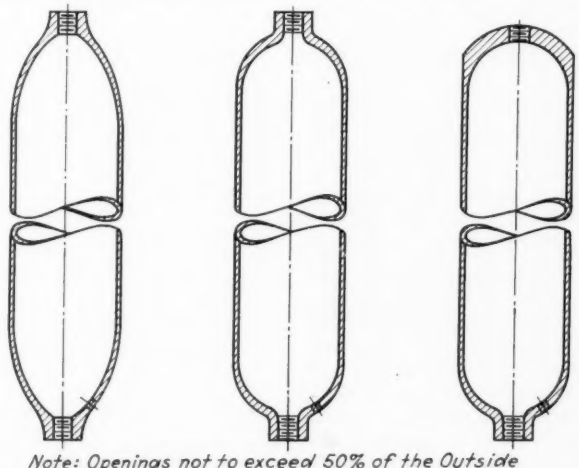
(3) The streamlined design as shown in the sketch below incorporates:

(a) No stress raisers such as openings, welded attachments, or stamping on the shell portion.

(b) Integral heads, hot formed, concave to the pressure, and so shaped and thickened as to provide details of design and construction of the center openings which will be as safe as those provided by the rules of the Code; center openings not exceeding 50 per cent of the diameter of the vessel or 3 in. pipe size; other openings in the head not exceeding 3/4 in. pipe size; openings shall be placed at a point where the calculated stress, without holes, is not more than one eighth of the specified minimum tensile strength.

(c) No welding.

(4) The completed vessel, after all



CASE No. 1205—TYPICAL SECTIONS OF SPECIAL SEAMLESS VESSELS

forming operations, is heat-treated by one of the applicable methods outlined in A 372. When oil quenched and tempered, forgings shall be subjected to a magnetic particle inspection as outlined in ASTM A 275, to detect the presence of quenching cracks on the outside surface of the shell portion. A crack which is not removed within the minimum thickness limit of the shell is cause for rejection.

(5) The tensile properties are determined by the testing method outlined in ASTM A 372-53T using specimens which are representative of each lot and which are selected after the final heat treatment of the lot.

(6) Each vessel that is subjected to a heat-treatment involving an oil quench and temper shall be hardness tested at 5-ft intervals with a minimum of three different locations representing approximately the center and each end of the heat-treated shell. The average of individual hardness readings at each location shall not be less than 225 Brinell nor more than 300 Brinell, and the highest average hardness shall not exceed the lowest average hardness on an individual vessel by more than 40 Brinell number (Other hardness testing methods may be used and converted to Brinell, using the tables in ASTM E 48.) Reheat-treatment is permitted.

(7) Maximum allowable working stresses shall be *one fourth* the specified minimum tensile strength given in ASTM A 372-53T except that maximum allowable working stresses of *one third* the specified minimum tensile strength may be used under the following limitations:

(a) The vessel is not subject to corrosion on the interior or exterior.

(b) The vessel is not subject to shock or rapid cyclic operation.

(c) Each vessel, regardless of heat-treatment, is subjected to a magnetic particle inspection as outlined in ASTM A 275, to detect the presence of quenching cracks on the outside surface of the shell portion. A crack which is not removed within the minimum thickness limit of the shell is cause for rejection.

(d) The vessel is stamped on the thickened head portion with both the maximum allowable working pressure based on a stress equal to one fourth the specified min tensile strength and also the maximum allowable working pressure based on a stress equal to one third the specified minimum tensile strength. The marking "Case No. 1205" shall be stamped following the latter pressure marking.

Case No. 1206

(Special Ruling)

Inquiry: Pending further review of practical experience data made available to the Committee, may the provisions of Par. P-268 and Table P-12 included in the 1952 edition of Section I be used for construction of boilers instead of the revision issued as an Addenda in 1954?

Reply: It is the opinion of the Committee that pending further review either the provisions of Par. P-268 and Table P-12 of 1952 edition of Section I or the Addenda of 1954 may be used in the construction of boilers.

Case No. 1207

(Special Ruling)

Inquiry: May seamless steel pipe having 70,000 psi minimum tensile strength be used in the construction of high-pressure boilers and pressure vessels under the rules of the Code?

Reply: It is the opinion of the Committee that carbon steel seamless pipe having 70,000 psi minimum tensile strength may be used for Code construction. The pipe shall be manufactured in compliance with the requirements of SA-106 with the following modifications:

(a) The carbon content shall not exceed 0.32 per cent by ladle analysis or 0.35 per cent by check analysis. Other chemical elements shall be as listed for SA-106, Grade B.

(b) The physical properties shall meet the following minimum requirements.

Tensile strength	70,000 psi
Yield point	40,000 psi
Elongation in 2 in. in the longitudinal direction of a standard round 2-in. gage length	20% min

(c) The flattening test shall be as required for SA-106, Grade B.

(d) The grade designation for marking shall be "70,000 T.S. A-106 SPCL."

(e) The maximum allowable stresses are:

—20 to 650 F	700 F	750 F	800 F
17,500	16,600	14,750	12,000

Annulment of Cases

The following cases are to be annulled:

CASE NO.	REASON FOR ANNULMENT
1137	The essence of the Case is now included in Section IV.
1144	Boilers operated in unit systems, now included in Par. P-23(a).
1149	Permission to use revisions to Section I, now included in Code.
1162	Radiographic porosity standards, now included in Par. P-102(h)(8)(c).
1169	Substance of this Case now included in Case No. 1197.
1178	Pressure-temperature ratings for flanges, now included in Sections I and VIII.
1186	Permission to use revised Par. P-268 now included in 1954 Addenda.
1193	Ring-reinforced furnaces, now included in 1954 Addenda.

Proposed Revisions and Addenda to Boiler and Pressure Vessel Code . . .

As NEED arises, the Boiler and Pressure Vessel Committee entertains suggestions for revising its Codes. Revisions approved by the Committee are published here as proposed addenda to the Code to invite criticism. If and as finally approved by the ASME Board on Codes and Standards, and formally adopted by the Council, they are printed in the annual addenda supplements to the Code. Triennially the addenda are incorporated into a new edition of the Code.

In the following the paragraph numbers indicate where the proposed revisions would apply in the various sections of the Code.

Comments should be addressed to the Secretary of the Boiler and Pressure Vessel Committee, ASME, 29 West 39th Street, New York 18, N. Y.

Power Boilers, 1952

TABLE P-7 Add the following sentence to Note 11 to read: "When material to this specification is used for boilers, water wall, superheater and economizer tubes, that are enclosed within a setting, the stress values above 700 F up to and including 850 F may be divided by a factor of 0.085."

Substitute the following for that contained in the June, 1955, issue of MECHANICAL ENGINEERING: "Under SA-268, Grades TP-405, TP-410, and TP-430, delete the stress values above 700 F under Pipes and Tubes, Seamless Alloy Steel & Welded Alloy Steel."

PAR. P-22(a) Add the following to the description of e as used in the formula:

$e = 0.04$ over a length at least equal to the length of the seat plus 1 in. for tubes expanded into tube seats, except

$e = 0$ for tubes expanded into tube seats provided the thickness of the tube ends over a length at least equal to the length of the seat plus 1 in. is not less than the following:

0.095 inches for tubes $1^1/_4$ in. O.D. and smaller

0.105 inches for tubes above $1^1/_4$ in. O.D. and up to 2 in. O.D., inclusive

0.120 in. for tubes above 2 in. O.D. and up to 3 in. O.D., inclusive

0.135 inches for tubes above 3 in. O.D. and up to 4 in. O.D., inclusive

0.150 in. for tubes above 4 in. O.D. and up to 5 in. O.D., inclusive

e = 0 for tubes strength-welded to headers and drums.

TABLE P-2 Revise as shown below.

PAR. P-186 Add specification SA-178 to the list of specifications in the last paragraph of (c).

PAR. P-112 Add the following to the end of Par. P-112(a)(5) to read: "...the furnace gases; (see Par. P-300 for American Standard Socket Welded Flanges)."

PAR. P-300 Revise the last sentence of the fourth paragraph to read: "American Standard slip-on flanges, not exceeding 4 in. nominal pipe size, may be attached to piping..."

Add a sentence to the fourth paragraph reading: "American Standard Socket Welded Flanges may be used in piping provided the dimensions do not exceed 3 in. nominal pipe size for 600 psi and lower classes, and $2^1/_2$ in. in the 900 and 1500 psi classes."

Low-Pressure Heating Boilers, 1952

PAR. H-39 Delete the last sentence and revise to read: "The required minimum capacity of the cushion tank may be determined from the following table or from the formula in the next paragraph. Provisions must be made for draining the tank without emptying the system."

Add the following after the present table and footnote:

The following formula may be used when the necessary information is available

$$V_t = \frac{.00041\,T - .0466\,V_s}{(P_a/P_f) - (P_a/P_o)}$$

where V_t = minimum volume of tanks, gal.
V_s = volume of system, not including tanks, gal
T = average operating temperature, deg F
P_a = atmospheric pressure, psia
P_f = fill pressure, psia
P_o = maximum operating pressure, psia

PAR. H-92 Revise as given above in Par. H-39.

Unfired Pressure Vessels, 1952

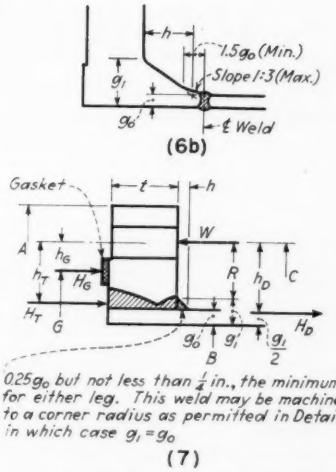
PAR. UA-6(b)(4) Add as note:

NOTE: These formulas are approximate in that they do not take into account continuity between the flange ring and the dished head. A more exact method of analysis which takes this into account may be used if it meets the requirements of Par. U-2. Such a method should parallel the method of analysis and allowable stresses for flange design in Appendix II.

PAR. UG-76 Delete the last sentence of (b). Add the following as (c):

(c) Exposed inside edges shall be rounded (grinding permitted) to a radius of at least $^1/_8$ in. as shown in Fig. UW-16.1 or may be chamfered at 45 deg to at least $^5/_{32}$ in. flat.

FIG. UA-48 Revise Sketch 6(b) to indicate that the hub slope from the flange intersects the h dimension line at their intersection with the continuation of the outside surface of the shell (the g_o dimension line). Also a maximum slope of 1:3 is to be shown for the distance of $1.5g_o$. Sketch 7 is revised to show a distance of $g_1/2$ to the force line H_D and the dimension g_o to be moved to indicate the shell or neck thickness. This will then be comparable to Sketch 5. Add the following to the note of Fig. UA-48 in Detail (7): "This weld may be machined with a corner radius as permitted in Detail (5) in which case $g_1 = g_o$." The revised figure is shown above.



REVISED DETAILS OF FIG. UA-48

PAR. UHA-11(c)—add the following sentence: "The maximum allowable stress values for materials with columbium added shall be the same as given in Table UHA-23 for Types 309, 310, and 316 respectively."

TABLE P-2 MAXIMUM ALLOWABLE WORKING PRESSURES FOR SEAMLESS STEEL AND ELECTRIC-RESISTANCE-WELDED STEEL TUBES OR NIPPLES FOR WATER TUBE BOILERS, WHERE EXPANDED INTO DRUMS OR HEADERS, FOR DIFFERENT DIAMETERS AND GAGES OF TUBES CONFORMING TO THE REQUIREMENTS OF SPECIFICATIONS SA-83, SA-178 GRADE A, AND SA-192.

Wall Thickness	Nearest Gage	1/2	3/4	1	1 1/8	1 1/4	1 1/2	1 3/4	2	2 1/4	2 1/2	2 3/4	3	3 1/4	3 1/2	3 3/4	4	4 1/2	5
0.055	17−	400	160	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
0.065	16	910	480	270	210	160	...	...	...	...	...	...	...	...	...	...	...	...	...
0.075	15+	1470	820	520	420	350	230	...	...	...	...	...	...	...	...	...	...	...	...
0.085	14+	...	1180	780	650	550	400	290	210	...	...	...	...	...	...	...	...	...	...
0.095	13	...	...	...	1910	1650	560	430	340	260	200	160	...	...	...	...	...	...	...
0.105	12−	...	...	...	...	1890	1470	1180	980	370	300	240	190	...	...	...	...	...	...
0.120	11	...	...	...	...	...	1770	1430	1180	1000	860	740	650	270	220	190	...	...	...
0.135	10+	...	...	...	...	...	...	1680	1400	1180	1020	890	780	690	610	550	490	...	...
0.150	9+	...	...	...	...	...	...	1950	1620	1370	1180	1030	910	810	720	650	580	480	400
0.165	8	...	...	...	...	...	...	...	1850	1570	1350	1180	1040	930	830	750	680	560	470
0.180	7	...	...	...	...	...	...	...	...	1770	1530	1340	1180	1060	950	860	780	650	550
0.200	6−	...	...	...	...	...	...	...	...	...	1770	1550	1370	1230	1100	1000	910	760	650
0.220	5	...	...	...	...	...	...	...	...	...	...	1770	1570	1400	1260	1150	1040	880	750
0.240	4+	...	...	...	...	...	...	...	...	...	...	...	1770	1580	1430	1300	1180	1000	860
0.260	3+	...	...	...	...	...	...	...	...	...	...	...	...	1770	1600	1450	1320	1120	960
0.280	2−	...	...	...	...	...	...	...	...	...	...	...	...	1960	1770	1610	1470	1250	1070
0.300	...	...	...	...	...	...	...	...	...	...	...	...	...	...	1950	1770	1620	1370	1180
0.320	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	1930	1770	1500	1300
0.340	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	1920	1630	1410
0.360	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	1770	1530
0.380	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	1910	1650
0.400	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	1770
0.420	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	1890

(1) These values have been calculated by the formula in P-22(a), using allowable stress values at a temperature of 700 F, from Table P-7. Values above the solid line include an additional thickness of 0.04 in. to compensate for thinning of tube-ends due to the expanding process.

(2) Where calculated allowable working pressures exceeded an even unit of 10 by more than 1, the next higher unit of 10 is given in the table.

ASME NEWS

With Notes on the Engineering Profession

A ceramic plaque depicting the gift of fire to mankind by Prometheus was presented by Ove Guldberg, *right,* secretary of the Danish Institution of Civil Engineers, to David W. R. Morgan, ASME President. The plaque, a reproduction of a 14-ft figure which decorates the Danish Engineers Convention Hall in Copenhagen, Denmark, was prepared as a greeting to the Society on the occasion of its Diamond Jubilee celebration. The Danes were joined by 13 other foreign engineering societies in presenting greetings to the ASME during the Diamond Jubilee Semi-Annual Meeting, Boston, Mass., June 19 through 23, 1955.

Greetings of engineering and scientific organizations throughout the world were presented to ASME at its 75th Anniversary convocation. *Left to right* are Arthur Clifford Hartley, Mem. ASME, vice-president of The Institution of Civil Engineers of Great Britain, who presented the greetings of 14 engineering societies from abroad; Warren Weaver, chairman of the board, American Association for the Advancement of Science, representing 16 scientific societies and fraternities in the United States; and Sir Vincent de Ferranti, chairman of the World Power Conference, who acted for four international engineering organizations.

ASME Diamond Jubilee Semi-Annual Meeting Discusses Engineer and the World of Science

Historic Boston sets scene for record technical program, numerous inspection tours, and many social events

With the energetic committee of the Boston Section at the helm, the Diamond Jubilee Semi-Annual Meeting of The American Society of Mechanical Engineers attracted more than 1500 ASME members, wives, and guests from all parts of the world to the Hotel Statler in Boston, Mass., during the week of June 19, 1955.

Features at the meeting were the 75th Anniversary Convocation and two panel sessions devoted to the theme, "The Engineer and the World of Science."

In addition, the program included 41 technical sessions at which 102 papers were presented; four inspection tours of government, manufacturing, and research facilities; and numerous social events including a Boston "Pops" concert, several tours of the city and outlying areas, and a clambake at Plymouth Harbor.

Four of the technical sessions were held jointly with the American Rocket Society, an ASME affiliate, which is celebrating its 25th Anniversary this year.

Engineer and the World of Science

75th Anniversary Convocation. At the Convocation on Tuesday afternoon greetings to ASME were presented by 16 scientific institutions of the United States, 14 engineering societies from outside the United States, and four international engineering organizations.

Congratulations were tendered on behalf of U. S. scientific societies and fraternities by Warren Weaver, chairman of the board, American Association for the Advancement of Science; on behalf of engineering societies from abroad by Arthur Clifford Hartley, vice-president, The Institution of Civil Engineers (Great Britain); and on behalf of international engineering organizations by Sir Vincent de Ferranti, Kt., chairman, World Power Conference.

Following the presentation of greetings, members of the first panel delved into the sub-

ject of "The Relationships of the Engineer and His Fellow Scientist."

Physical Sciences. Leading off the panel, Frederick G. Keyes, Mem. ASME, Professor of Physical Chemistry, Massachusetts Institute of Technology, Cambridge, Mass., said that war gave birth to the art of mechanical engineering more than 2000 years ago. Whether that art will rescue mankind from the threat of exhaustion of natural fuels, he pointed out, depends on whether the prospect of constructive progress is interrupted by a "continuing demonstration of mankind's supreme incompetence: His age-long inability to abolish war."

Professor Keyes traced the connection between the construction of war machines and the development of mechanical devices back as far as the Byzantines in the second century before Christ. Before them came Archimedes, born in 287 B. C., "the greatest natural philosopher, mathematician, and mechanical engineer of antiquity."

Biological Sciences. Dr. Bostwick H. Ketchum of the Woods Hole Oceanographic Institution, Woods Hole, Mass., warned that man finally has it in his power to contaminate the vast ocean areas.

"The quantity of atomic power that may be developed within our lifetime," he said, "would produce enough radioactive waste products within a year to make a detectable change in the ocean, even though they were uniformly distributed from shore to shore."

Successive accumulations, he added, would have an unpredictable influence on the whole biological cycle of the sea.

He reminded his audience that "man is important to himself, but not terribly important to biological life."

"If we were all to disappear from the face of the earth tomorrow," he said, "most of life would go on unchanged. However, if the process of photosynthesis by green plants were to stop tomorrow, man would continue to live only as long as the stock on the grocer's shelf lasted."

He urged engineers to think of future generations in tackling such problems as stream pollution and flood control.

According to Dr. Ketchum, all engineering practices and advances have direct biological consequences. Nature can be conquered or controlled for the benefit of man only on her own terms.

Medical Sciences. The modern doctor wears many hats—too many, according to Carl W. Walter, M.D., Surgeon, Peter Bent Brigham Hospital, and Associate Clinical Professor of Surgery, Harvard Medical School, Boston, Mass.

Dr. Walter charged that the engineering and medical professions have failed to effect a division of labor "in the care of the patient whereby the physician is able to wear his doctor's hat more securely and effectively because his ancillary services are engineered for greater efficiency."

He warned engineers to "guard aginst the dangerous fever that captivates enthusiastic laymen—'doctoritis.' It results in identification with the wrong function—an engineer in a doctor's hat is an ineffectual absurdity."

He listed four reasons for failure of the engineering approach to solve medical problems or to bring satisfaction of accomplishment in return for engineering effort expended:

1 Inadequate definition because of inability of the engineer to interpret the medical problem.

2 Failure to see the larger problems of which special problems are a part. In this connection, he pointed to the example of several needle sharpeners and washers now reaching the market. All concentrate on single functions, he said, and ignore the mounting industrial problem of processing needles—allergic dermatitus from repeated contact with residual antibiotics and homologous serum hepatitus from pricked fingers.

3 Expenditure of effort on problems of too narrow scope or of no practical import. Most special instruments designed by "enthusiastic" surgeons with a fetish for instrumentation fall into this category, he said.

4 Premature launching of research projects.

Reginald J. S. Pigott, past-president and Fellow ASME, served as chairman of the panel.

Shortage of Engineers. Speaking at the second Anniversary Panel on Wednesday morning, Sir Vincent de Ferranti of England, Hon. Mem. ASME, chairman of the World Power Conference, said that the solution to the pressing shortage of engineers may lie in a radical change in our system of education. He charged that conventional methods of education may hamper initiative.

The most obvious answer to the problem of training engineers, he said, "is that there should be available a number of different methods designed to suit a variety of human types."

He added that the grammar school and the university engineering course may meet the needs of many, but for some others they stifle human curiosity.

One promising prospect, he said, is the "sandwich" course now being developed in the United Kingdom, in which the student carries on his academic education concurrently with his work for an engineering firm.

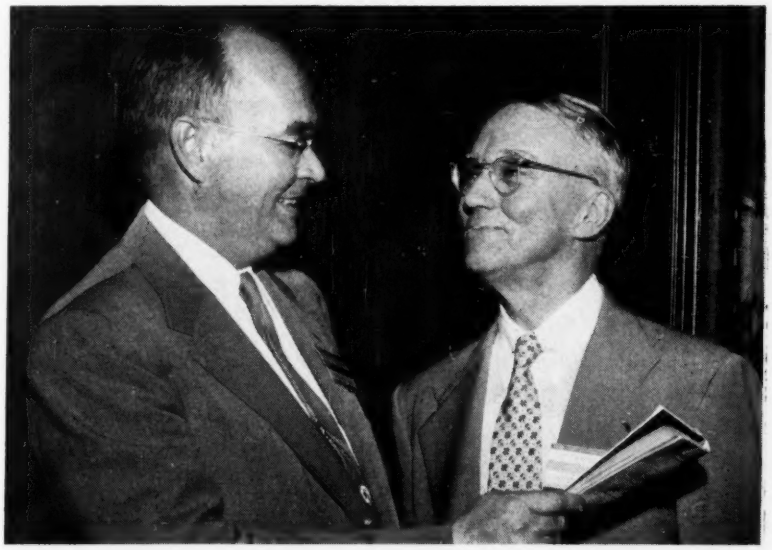
"At all times," Sir Vincent said, "the student is at least aware of real problems in the factory urgently demanding solution. This is of itself a useful corrective for certain active types of mind which experience a sense of frustration, of mental indigestion, when the theories with which they are freely supplied appear to lack relevance to any real experience."

Human-Relations Problems. Richard E. Heartz, Hon. Mem. ASME, and President of The Engineering Institute of Canada, urged engineers and scientists to join hands to solve the human-relations problems created by the atomic age.

He told the audience that the engineer and the scientist have accomplished much, but they face a future that will challenge them beyond their wildest imagination. They are a team, and they must remain so, if they are to meet and conquer the monumental problems of the future. Not the least of these problems will be their responsibility to society.

International Co-Operation. "Science has long been conceded to be international. Research in basic sciences is international property."

The president of the International Organization for Standardization, Hilding V. Tornebohm of Sweden, Hon. Mem. ASME, made that statement in the final panel talk.



"The Relationships of the Engineer and His Fellow Scientist" was the topic of the ASME 75th Anniversary panel, during the Diamond Jubilee Semi-Annual Meeting. Bostwick H. Ketchum, *left,* of the Woods Hole Oceanographic Institute, Woods Hole, Mass., related the professional activity of the engineer to the biological sciences. Frederick G. Keyes, *right,* Mem. ASME, professor of physical chemistry at the Massachusetts Institute of Technology, discussed the connection of engineering with the study of physical sciences.

Dr. Tornebohm listed six fields in which international co-operation has contributed to progress:

1 Telegraph and telephone communications between countries.

2 Postal agreements that make it possible for persons in different countries to correspond freely.

3 The work of the International Bureau on Weights and Measures, established in 1875 to bring standardization into that field.

4 The work of the International Electrotechnical Commission, established in 1904 in St. Louis, to effect co-operation among technicians and others in the growing applications of electricity.

5 Railroad agreements that make it possible for travelers to remain on one train while crossing many borders.

6 The work of the International Civil Air Organization, a group devoted primarily to safety, whose efforts have made it possible for a pilot to enter any airport in the world even though he has never seen it before, and to land safely without knowing the language.

Dr. Tornebohm concluded with a tribute to the engineering journals of all nations, which he described as important tools in the necessary work of international co-operation.

Chairman of the panel was William L. Batt, past-president and Hon. Mem. ASME. He is a former president of SKF Industries, Inc., and served as U. S. Minister of Economic Affairs to the United Kingdom.

Luncheons and Banquet

President's Luncheon

David W. R. Morgan, ASME President, in his address at the President's Luncheon of the Diamond Jubilee Semi-Annual Meeting, Monday, June 20, praised New England for its combination of "the best works of man, both of the mind and the spirit."

In his speech, which keynoted the theme, "The Engineer and the World of Science," he said, "This is a suitable location for this discussion because Boston, along with the rest of New England, is proving that it can develop new industries by vigorous research. We can all take inspiration from the way that New England combines the best works of man, both of the mind and the spirit. I believe, for instance, that the Massachusetts Institute of Technology is as important in the scheme of things as its neighbor, Harvard—neither more nor less so. I like to think that there is not too great a gap between the men who create the wonderful music that fills this city and the men who built the world's first atomic submarine not too far from here. We engineers are as anxious for the health of the *Atlantic* magazine as for the success of many of our technical publications, for we know that both are essential to the world in which we live."

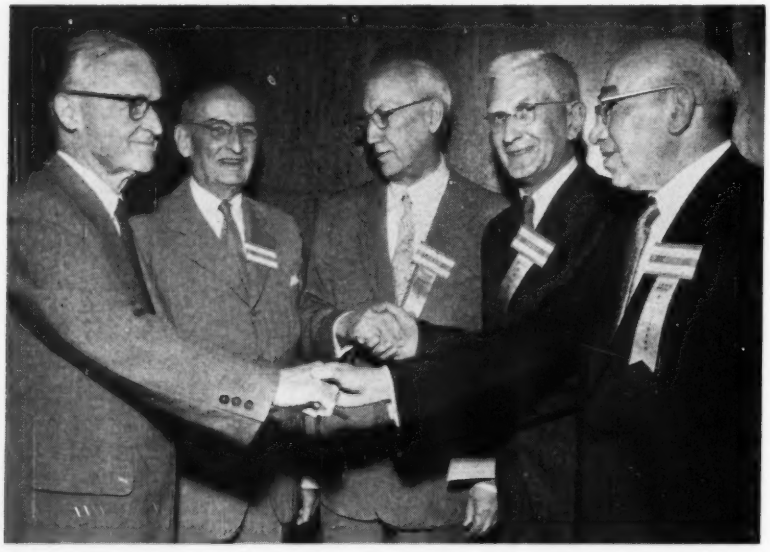
Elaborating on the theme, Dr. Morgan outlined three concepts that he said engineers must understand in dealing with the world of science:

1 That rapidly expanding technology puts new tools at the command of engineers;

2 That the process of formal education and practical training of the mechanical engineer must be given critical scrutiny so that these engineers may be better able to deal with the greater responsibilities of the future; and

3 That engineers must learn more about the related fields of science.

L. K. Sillcox, past-president and Hon. Mem. ASME, served as toastmaster at this luncheon.



Four past-presidents of ASME join current President, David W. R. Morgan, *right*, in a round of handshakes prior to the President's Luncheon. Shown, *left to right*, are D. Robert Yarnall, partner in Yarnall-Waring and Company, Philadelphia, Pa.; Harold V. Coes, retired vice-president of Ford, Bacon & Davis, New York, N. Y.; E. G. Bailey, chairman of the board, Bailey Meter Company; and Lewis K. Sillcox, honorary vice-chairman of the board of New York Air Brake Company.

Honors and Awards Featured on Banquet Program

Nearly 500 ASME members and guests were on hand at the banquet Tuesday evening, to witness the conferring of honors and awards upon eminent engineers and scientists and to hear an inspiring address by Detlev W. Bronk, Hon. Mem. ASME, president of the National Academy of Sciences, and president of the Rockefeller Institute for Medical Research.

With Frederick S. Blackall, jr., past-president and Fellow ASME, acting as toastmaster, the following "Fifty-Year Members of ASME" were recognized: Redfield Proctor, Proctor, Vt.; Charles Huntington Turner, Fort Pierce, Fla.; and Edward Vinton French, Andover, Mass. None was present.

A 75th Anniversary Medal was presented to Alfred J. Ferretti, Mem. ASME., as "the member of the Boston Section who has done the most to further the aims and objects of ASME."

The 1955 ASME George Westinghouse Gold Medal was awarded to Hyman G. Rickover, "for eminent achievement in the power field of mechanical engineering as exemplified by the successful completion of the submarine U.S.S. *Nautilus*, in which by his foresight, determination, and leadership, the idea of nuclear-power generation was transformed from speculation to reality."

Honorary Memberships in ASME were conferred upon the following:

Jacob Ackeret—"eminent contributor to basic theory in aeronautics and mechanical engineering; international leader in teaching and research in the fields of fluid mechanics and aerodynamics."

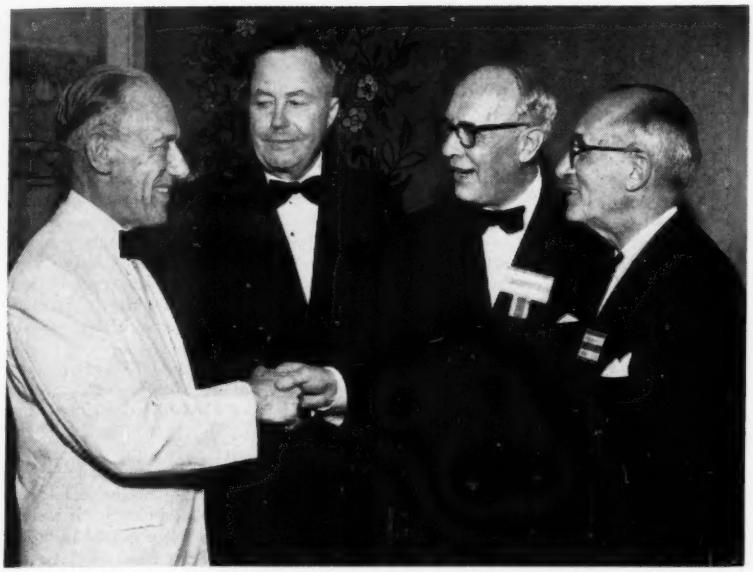
Detlev W. Bronk—"eminent national leader in science with recognized attainments in applying science and engineering to research in the fields of physics, medicine, marine biology, and atomic energy; able educator, editor, and lecturer."

Sir Vincent de Ferranti, Kt., M.C.—"international leader in the fields of power generation, radio, and electrical manufacturing; eminent electrical engineer, organizer, and industrialist; chairman of the International Executive Council of the World Power Conference."

Richard Edgar Heartz, Mem. ASME—"eminent engineer and constructor of important power projects; director of Canada's wartime shipbuilding and ship-repair activities, president of the Engineering Institute of Canada." (Deceased since election.)

Ernest Frederic Mercier—"eminent engineer, inventor, educator, and industrial leader, whose accomplishments in the fields of mechanical and electrical engineering, management, finance, and international relations have been outstanding; a leader of his profession in France." (Deceased since election.)

Hilding Valdemar Tornebohm, Fellow



Honorary membership, the highest rank of membership in the ASME, was bestowed on four men of science and engineering during the banquet. Shown, *left to right,* are Detlev W. Bronk; Richard E. Heartz, president of The Engineering Institute of Canada; Hilding V. Tornebohm, vice-president of Svenska Kullagerfabriken (SKF), Gothenburg, Sweden, and president of the International Organization for Standardization; and Sir Vincent de Ferranti, chairman and managing director of the English electrical firm of Ferranti, Ltd., and chairman of the World Power Conference. Also receiving honorary memberships, but not present, were Ernest F. Mercier, French industrialist, who died recently, and Jacob Ackeret, professor at the Federal Institute of Technology, Zurich, Switzerland.

A reception followed by dancing concluded the evening's program.

Machine Design Luncheon

Addressing the Machine Design Luncheon, Wednesday, June 22, Richard Alt, staff associate of Arthur D. Little, Inc., Cambridge, Mass., told a large audience of engineers that the promise of industrial growth in New England lies in research.

In his survey of the present status of research effort in New England, Mr. Alt disclosed the following information. The area contains 11 per cent of the nation's industrial laboratories, which compares favorably with its approximate ten per cent of total manufacturing employment. New England has 462 independent research laboratories, which form the major support for the region's research base. Of 435 members in the National Academy of Science, more than 20 per cent—92 in all—are from New England. Researchers in New England apparently are paid less than the national average, but remain in their jobs because of what economists like to call "psychic income," or the many advantages of living in the area.

"In my opinion," Mr. Alt concluded, "the most significant thing is New England's demonstrated ability to create new products and new processes. This is the important fact underlying research-based industry in New England."

Toastmaster at this luncheon was John Haydock, Mem. ASME, chairman, ASME—"eminent machine designer, teacher, and author; outstanding contributor to the development of precision machine tools and to gaging techniques and tolerances; acknowledged leader in the field of standardization; president of the International Organization for Standardization."

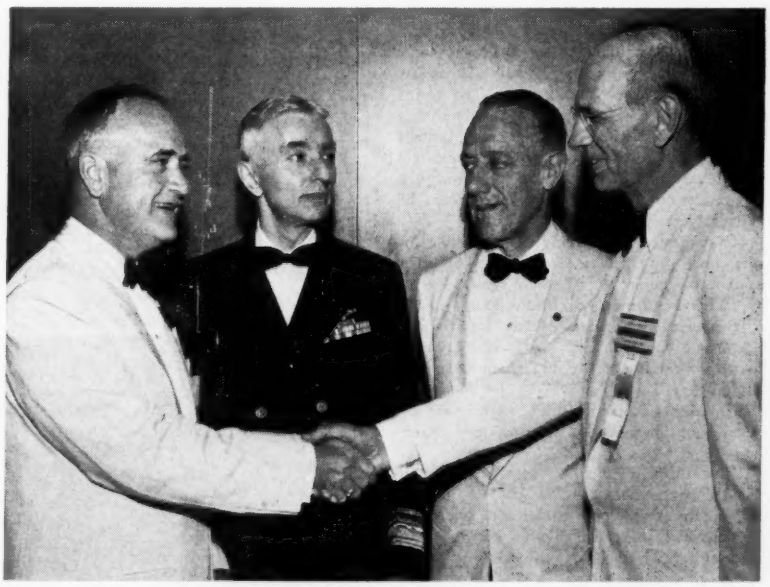
Detlev W. Bronk, principal speaker at the banquet, called on American engineers to "increase the scope and power of the human body" by creating "machines for man, to be used as man desires."

"The blast of the first two atomic bombs," he said, "awakened man to an awareness of the human implications of the forces released by man."

He praised engineers for their instruments that "enable the greater understanding of man, not only as a living machine, but as a machine with spiritual quality." Among such instruments he listed the microscope, the Roentgen-ray machine, and electronic amplifiers for the study of the brain and nervous system.

Mr. Blackall, who introduced the speaker, paid tribute to Boston's financial community, "which is enthusiastically seeking new fields of investment in corporations whose activities are based on scientific research and development."

"Those who believe that the Yankee will not take a chance do not know their New England," Mr. Blackall said, "and those who dismiss the area as economically moribund are blind to the enormous changes which have taken place in New England's industrial economy."



Four leading figures at the ASME Diamond Jubilee Semi-Annual Meeting gather prior to the main banquet. Shown, *left to right,* are: F. S. Blackall, jr., past-president and Fellow ASME and president-treasurer of The Taft-Peirce Manufacturing Company, Woonsocket, R. I., who served as toastmaster of the affair; Rear Admiral Hyman G. Rickover, developer of the world's first atomic-powered submarine, the U.S.S. *Nautilus,* and recipient of the 1955 George Westinghouse Gold Medal; Detlev W. Bronk, president of the National Academy of Sciences and president of the Rockefeller Institute for Medical Research, who delivered the main banquet address; and Alfred J. Ferretti, Mem. ASME, head of the mechanical-engineering department of Northeastern University, recipient of ASME 75th Anniversary award.

Richard Alt, staff associate of Arthur D. Little, Inc., Cambridge, Mass., told a Machine Design Luncheon audience that the greatest promise of industrial growth in New England is contained in the density of research facilities and personnel in the area

Machine Design Division; editor, *Metal Working*, Sutton Publishing Company, White Plains, N. Y.

Textile Engineering Luncheon

The textile industry was challenged to put all its production processes on an automatic basis by Stephen S. Marks, associate editor of the trade publication, *Daily News Record*, New York, N. Y.

Speaking at the Textile Engineering Luncheon held on Thursday, June 23, Mr. Marks called for the engineers to strive for new and more economic ways to increase the use of weaves in fabrics. He asked: "If an entire chain of operation in a modern manufacturing plant can be activated by punch cards, is such a thing out of the question for textiles? With every end of a warp drawn through a separately controlled heddle, could these be efficiently activated by an IBM card?"

He suggested that it might be possible for one controlling machine-punch card or other system to regulate the weave on several looms.

"When I consider the millions upon millions just invested by General Motors and Ford in automatic controls," he said, "the question arises if that is not the inescapable trend for all industry."

Mr. Marks reminded his audience that the textile-consumer market is constantly changing.

"Just think," he said, "of what has happended since the development of heat-set nylon fabrics and the utilization of fine yarns. It practically has pushed other fabrics out of the nightgown and slip business. According to an advertising writer, 'It's better than nudity at night.' Nylon and tricot was a wonderful wedding. Could there be such a match of some other yarn and a loom? If there was, it certainly would bring back a lot of lost yardage."

Leslie A. Runton, Mem. ASME, chairman, ASME Textile Engineering Division; director of engineering, Alexander Smith, Inc., Yonkers, N. Y., presided.

Technical-Program High Lights

Nuclear Engineering. Engineers present at the 1955 ASME Semi-Annual Meeting heard the first detailed description of a "package" nuclear-power reactor to be built by the American Locomotive Company. The plant, which will be put in operation within three to four years, was designed in response to the need for small, specialized reactor plants, the components of which can be flown in commercial-type aircraft to remote locations and assembled in a relatively short construction period. Cost of the installation will be $2,096,753. The plant will be used at Fort Belvoir, Va., for test purposes. Net electric-power and steam-heat output will be 1000 kw and approximately 3500 kw, respectively.

Another paper pointed out that oils and greases will not play an important part as lubricants for moving parts in the water-cooled reactor section of atomic-power plants. Therefore bearing materials that would be compatible using the cooling water as the lubricant had to be found. The paper described the many tests made on sliding, roller, and ball-type bearings. On sliding-type bearings graphite materials were found to be the only ones suitable for high speeds and loads up to 100 psi, provided the journal material was compatible with carbon. Titanium carbide proved superior to other materials when used with carbon.

Initial tests on roller bearings included needle, tapered roller, and special barrel-type rollers. Results were such that tests on these types were discontinued in favor of further work on ball bearings.

The most troublesome feature on ball bearings was the metallic retainers; they were a constant source of galling and scoring. Thus tests were conducted without retainers but with spacer balls placed alternately between the load balls and with micarta, nylon, and rubber retainers.

Other nuclear papers covered engineering problems of power reactors and fast reactor accident dynamics.

Materials Handling. The word "automation" has been in use for only eight years; the practice of automation, though, is about 175 years old.

That was the conclusion of a paper that traced the beginnings of automation back to the 1780's, when Oliver Evans designed an automatic grist mill in Philadelphia. The mill contained "an ingenious combination of belt conveyers, screw conveyers, and endless-chain buckets that took the grain automatically through cleaning, grinding, and golting." The mill was automatic from the unloading of the grain to the barreling of the flour. A few years later a similar mill was constructed in Virginia.

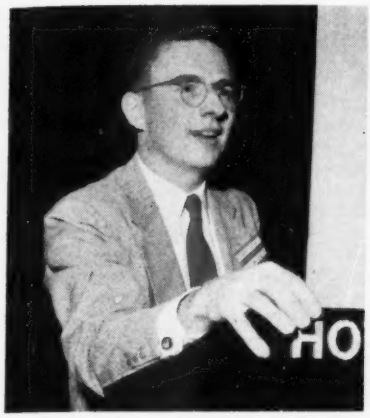
The paper also traced the development of automatic production techniques, including the principles of standardization, interchangeability, the continuous assembly line, and the transfer machine. The first true transfer machine, according to the paper, was probably the one built at the Morris automobile plant in Coventry, England, in 1924. It weighed more than 300 tons and was used to produce finished cylinder blocks from rough castings. There were 53 operation stages and 81 electric motors with a combined rating of 267 hp. It was actually a collection of standard machines attached to a continuous bed with a continuous table mounting the fixtures and jigs and a common control shaft to time the motion of all the heads.

Another paper revealed that more efficient stacking of containers could save $5 million a year at one government-warehouse installation alone. The report is the result of a Navy research program which has produced a simple chart method of determining pallet-load patterns for containers in a wide range of sizes.

Savings in warehouse space, costs, and manpower make this an important advance in mechanized industrial truck handling of palletized unit loads, the report said.

Although the pattern-pallet chart was developed for 40 × 80 in. pallets, the method and approach are general, permitting application to any other size of pallet, or to any definite area. To construct similar charts it is

Technical sessions devoted to nuclear engineering took the spotlight during the ASME Diamond Jubilee Semi-Annual Meeting. Topics discussed included boiling reactors, nuclear-power equipment, and safety considerations.



Anderson Ashburn, special projects editor, *American Machinist,* New York, N. Y., traces the history of automation during a Materials Handling-Production Engineering session

Prof. L. V. Colwell, Mem. ASME, University of Michigan, said, at a Metals Processing session, that surface finishes produced on steel by grinding can be improved by high-frequency vibrations

R. T. Van Ness of E. I. du Pont de Nemours & Company, Inc., Wilmington, Del., gives some pointers on designing for safer factories at a Safety-Management meeting

necessary only that boundary conditions be definable.

Production Engineering. Radioactivation of surfaces has been successfully used in the evaluation of wear produced by friction between rubbing surfaces during short periods of service, it was disclosed at the meeting.

The method was said to be applicable to studying wear on tools, gears, rams, and even automobile tires. The paper reported its use in studying the wear of die faces during hot extrusion of steels. This nondestructive method enabled study of wear under severe service conditions where the temperature of steel billets may be as high as 2400 F and pressure on the die is about 140,000 psi.

The technique permitted precise determination of the location of wear. Weak points and the concentrations of frictional forces could be determined when the amount of wear was extremely small. It was possible to observe and weigh particles of the abraded die with an accuracy of about one one-millionth of a gram (or about 2.2 billionths of a pound). Thus it was possible to evaluate the influence of temperature, ingot surface, rate of extrusion, die surface and lubricant, and other variable factors on wear. The method revealed the mechanism of die wear and the best shape for minimizing die wear and increasing die life.

A major electrical manufacturer has installed a cost-reduction program that is paying for itself at the rate of ten dollars for one, according to a paper sponsored jointly by the Production Engineering and Management Divisions.

The cost-reduction organization consists of three groups: Design engineering, purchasing, and manufacturing. Each group has a full-time co-ordinator, while other persons participate on a part-time basis.

Actual dollar savings are credited to a specific yearly target, which is established separately for each department. "Recognition credit" is given to groups that have assisted in making savings possible.

This credit is one of the most important aspects of a well-organized cost-reduction program since it insures co-operative relationship and maximum results.

Two types of goals are established every year for the amount of expected savings, a "production cost-reduction goal" and an "expense-reduction goal."

In addition to direct dollar savings, benefits derived from the program include improved quality, reduction of amount of material in transit, shortening of delivery dates, improvement of customer relations, and heightening of output.

Safety-Management. Great progress is being made in the never-ending battle against damage from fire and explosion. It was reported that although preventive measures are the first line of attack against fire, the greatest factor in cutting losses has been increased skill in holding down damage once the fire has started.

An outstanding recent improvement in automatic-sprinkler protection is the directional wide-angle spray nozzle, which was described as giving more even distribution of water and more consistent breakup of the water, without wetting the ceiling. Actual fire tests have provided conclusive evidence that wetting the ceiling was of less importance than even distribution of water. One result has been greater leniency in the spacing of automatic sprinklers and in water-supply requirements.

The paper also described test and research procedures for the formulation of safe practices for the design, construction, and operation of paint and enamel-drying ovens. One of the phases of this work was the development of flammable-vapor indicators, now widely used but still capable of greater application. Another phase is "explosion venting," which is a means of reducing the effect of explosions. This may be provided by properly placed window areas large enough to release the pressures produced.

Power. Research on the causes of silica carry-over from boilers was furthered by wide-range tests reported during the meeting.

Although the problem has been investigated widely, the previous data were not complete over the range of modern boiler operation, and often the data of several investigators fail to agree.

The fundamental purpose of this recent test, according to the paper, was to close some of the gaps by determining the distribution ratios of silica concentrations in steam to those in boiler water over a wide range of operating conditions.

The paper outlined the procedure for the test and reported the results as affected by vaporization and mechanical carry-over. The determinations were made over a range of pressures from 300 to 3140 psi, of silica concentrations in water from 12 to 1000 ppm, and of pH values of water from 7.8 to 12.1.

Mechanical carry-over, determined by using a radioactive tracer, was insufficient to necessitate corrections to the vaporous silica carry-over data at pressures above 500 psi. Use of the radioactive tracer was an entirely new technique for testing mechanical carry-over and was employed primarily because earlier investigators were unable to prove definitely whether mechanical carry-over was present or absent during their tests. The sensitivity of this method was found to surpass by far any other previously used procedure. The paper reported that it was possible to measure to 0.001 per cent moisture in the steam throughout the duration of the test.

Fuels. More precise automatic control of the shape of flames or of flame geometry is making the adaptation of heating processes to primary production lines increasingly practical. Product quality is thus improved, production costs are lowered, and a contribution is made to the progress of automation in industry.

It was reported that modern methods for controlling, accelerating, and stabilizing combustion have made possible the determination of flame geometry to an extent that makes it a useful tool for industry. This is especially true with the recent emphasis on automation, the possibility of adequate control with high thermal heads, and of

C. T. Appleton, vice-president, Reed Rolled Thread Die Company, Holden, Mass., *left,* points out features of a jackscrew with a rolled acme thread. In the *center* is Prof. M. C. Shaw, Mem. ASME, of the Massachusetts Institute of Technology. At *right* is John M. Bartlett, Jr., Mem. ASME, of Morgan Construction Company, Worcester, Mass. Mr. Appleton set up displays of various parts with rolled threads and forms for a Production Engineering session.

confining heat to a small and equal section of each successive part.

Optimum application of flame geometry was said to require separate and adequate control of fuel composition, fuel-air ratio, fuel-air mixture and pressure at the burner, burner design, draft conditions, workpiece placement in relation to burner, and duration of exposure. Five general burner types have been held under the precise control required in automatic production: The "ribbon" burner, the "spear-flame" or "needle" burner, the round-screen burner, the radiant ceramic burner, and the enclosed combustion burner.

Applications such as drying ink, removing moisture, and preparing plastic surfaces for ink reception, and heating sections of glass tubes for forming were cited to illustrate the precision that has been attained in flame geometry.

Metal Processing. Surface finishes produced on steel by grinding can be improved by high-frequency vibrations, it was reported. Investigations showed that such vibrations reduced the temperature in ground surfaces, reduced the incidence of thermal cracks, and minimized the effects of variations in hardness within a grinding wheel under test conditions.

Grinding tests were described in which vibrations of 0.001-in. amplitude at 10 to 18 kilocycles per second were induced between the workpiece and grinding wheel by vibrating specimens with an ultrasonic transducer consisting of a core of thin sheets of pure nickel wound with a copper-wire coil in which alternating current was applied.

Surface-roughness measurements and microscopic examinations of the grinding swarf, or dust, obtained during dry grinding showed a 60 per cent reduction of roughness, from 40 to 16 microinches, when grinding hardened 52100 steel with an F-grade aluminum-oxide wheel (DA60-F9-V20). The depth of cut was 0.002 in. and the cross-feed was 0.050 in. Peak temperature was reduced from 475 to 255 F as measured by thermocouple and oscilloscope.

It appeared generally true that vibration caused more wheel breakdown than conventional grinding. This was not unexpected, according to the paper. Studies of grinding ratio have confirmed varying degrees of more rapid wheel breakdown, particularly just after redressing. This was attributed to fewer and smaller built-up edges, and to continuous, uniform redressing which results from fragmentation of individual abrasive grains.

Process Industries. The advantages of prerotation vanes as a means of improving the part-load performance of constant-speed centrifugal refrigerating compressors were given.

The several methods available for reducing power input to partly loaded centrifugal compressors and for broadening their operating range were discussed.

According to the paper, one disadvantage of the centrifugal compressor is its characteristic of surging on light loads. This minimum capacity limitation prohibits continuous operation of the machine through the range from full to zero load; therefore wide variations in refrigerating load previously could be handled only by cycling a conventional machine on-and-off. This on-and-off operation above a minimum frequency is harmful to the driving motor and compressor. It increases the motor operating temperature and causes greater wear on sleeve bearings.

Studies of these problems led to the development of methods to reduce power input as the refrigerating load drops off and to broaden the operating range—move the surge point back nearer to zero load point.

According to operating curves presented with the paper, prerotation vanes installed at the entrance to compression stages offered the best solution to the operating problems. They broaden the stable operating range and, at the same time, reduce the power input as refrigerating load falls off, thus improving the machine's efficiency.

Instruments and Regulators. The benefits of "systems engineering" were explained in a paper that used as an example a fuel-supply system for an aircraft-engine test facility. For reasons of brevity the paper did not discuss the final design in detail, but did solve certain specific design problems with emphasis on application and numerical work. Both dynamic and steady-state performance of the process were considered.

As outlined, systems analysis prevents overemphasis of either the physical problem or the over-all performance requirements, so that the control configuration chosen is truly optimum and equipment selection is put on an economic basis.

Giving the spacing limitations, performance requirements, and range of operating conditions, the paper presented a design based on systems-engineering principles and derived (1) methods for defining the functional requirements for component parts, and (2) a satisfactory mathematical relationship between flow and pressure. The equations contained in the paper are also helpful in finding the optimum mode of control for the system and determining the control-valve location requirements.

Textile Engineering. New strides are being made in improved serviceability of nylon knitted and woven fabrics because textile-production officials have found new ways to impart crimp into man-made fibers.

One of more than a dozen newly designed fabrics dreamed up by the Fabric Development Section of E. I. du Pont de Nemours & Company, Inc., Wilmington, Del., is inspected by Harriet Treon. At *right* is J. T. Rivers, du Pont research supervisor, who brought the exhibit to a Textile Engineering session. Mr. Rivers stressed that the new bulk-type yarns, which provide extra cover, form a third major system of textile material.

The need for increased emphasis upon basic sciences in engineering curriculums was the subject of an Education-Junior-Management panel. *Left to right* are H. K. Ihrig, Allis-Chalmers Manufacturing Company; F. E. Reed, Jr., Mem. ASME, Arthur D. Little, Inc., Cambridge, Mass.; Kerr Atkinson, Mem. ASME, consulting engineer; and C. J. Freund, Fellow ASME, dean, College of Engineering, University of Detroit.

According to the papers, fuzziness (known in the trade as pilling) is being overcome by research going on simultaneously at several different places in the textile industry.

For example, one advantage of "Ban-Lon" is its applicability for fine tricot yarns.

It was pointed out that in some initial tricot trials, the weight for equal cover can be reduced about 70 to 75 per cent, so that new spun effects can be had in tricot with bulked filament yarns which produce weights of fabric two thirds to three fourths lower over the original uncrimped filament yarns.

The author called on textile-machinery manufacturers to "look strongly at the problems of handling bulked filament yarns."

"They are different from either spun or filament," he said. "There are problems in package construction, package-density controls, and tension controls which are unique."

He added that, "Similarly, chemical manufacturers and textile-specialty manufacturers should take a hard look at the growing textured-yarn field because problems in dyeing a bulked filament yarn are different from that of a plain filament yarn and very different from a spun yarn."

A second paper described "Taslan" textured yarn as one of "a third, major system of textile materials, morphologically different from both the staple and the continuous-filament systems." (Staple yarns are those made from short lengths of material, such as wool and cotton; continuous-filament yarns are the man-made synthetics.)

This paper revealed for the first time that there are more than 40 du Pont Company licensees in the United States and Europe

This trio of speakers addressed Production Engineering and Management sessions. *Left to right* are Lawrence J. Brozek, assistant divisional staff superintendent; Marvin B. Parmelee, supervisory buyer; and J. A. Miller, divisional staff superintendent, all of Westinghouse Electric Corporation's Transportation and Generator Division, East Pittsburgh, Pa. Cost reduction through manufacturing engineering was their subject.

Abraham Smaardyk, *left*, associate engineer with Argonne National Laboratory, Lemont, Ill., evaluated various types of bearing designs and bearing materials for use in component mechanisms for water-cooled, nuclear-powered plants. On the *right* is Floyd F. Dedrick, mechanical engineer with Stone & Webster Engineering Corporation, Boston, Mass., who presided over the Power-Nuclear Engineering session.

practicing the process for making Taslan at various stages of commercialization.

According to the paper, fabrics made from Taslan textured yarns, when compared with spun-staple fabrics made from equivalent-denier fabrics, have equal or lower bulk density, a drier, crisper "hand" (feel), significantly improved freedom from pilling and fuzzing, and much greater uniformity."

Another paper predicted that new fibers will be developed that will combine "the desirable features of the synthetics with what are still outstanding properties in the natural fibers."

Synthetic fibers, it was pointed out, will probably be produced that will simulate the felting qualities of wool.

The paper also said that the textile industry has hardly scratched the surface of its potentialities indicating that: "Not too long ago, the textile designer had but a few fibers from which to select his raw materials. Now he is confronted with a wide selection encompassing a correspondingly great diversity in physical and chemical properties. Methods of processing have become more varied and versatile. Processes, which once were limited to rather confined fiber lengths, now have their range of usable fiber staples greatly increased. Yarns are being spun from staple fiber with little or no twist. Fabrics are no longer being woven in the conventional manner. And" the author concludes, "the use of mechanical and chemical treatments are more diverse and effective than ever before."

Other papers on the ASME technical program covered applied mechanics, rubber and plastics, wood industries, heat transfer, hydraulics, metals engineering, management, machine design, fluid meters, gas-turbine power, aviation, and education.

Digests of 38 of the papers are published in the ASME Technical Digest Section of this issue of MECHANICAL ENGINEERING. The remaining papers will be abstracted in forthcoming issues of MECHANICAL ENGINEERING.

American Rocket Society. ARS sessions dealt mostly with rocket combustion, instrumentation, and fuels. Combustion instability, still one of the most serious problems in the development of liquid-propellant rocket engines (which will power the intercontinental ballistic missiles the U. S. is racing to develop ahead of Russia), was the subject of the papers.

At the ARS banquet on Wednesday evening, Prof. Paul E. Sandorff of M.I.T., told the rocket experts, among other things, that "it appears that space flight, when it comes, may be different in many respects from the way in which it is now popularly visualized." He went into detail on the logistics problems of an artificial satellite (currently widely discussed and perhaps on the drawing board but under security wraps), and the design of a space vehicle to meet the very severe problem of high-temperature effect on fuels and structures.

ASME Officers Nominated for 1956

MEMBERS of the ASME Nominating Committee for 1955, E. W. Allardt, *chairman;* R. C. Robertson, *secretary;* L. E. Seeley, P. C. Osterman, Guerard Mackey, J. G. Van Vleet, B. G. Dick, R. B. Stewart, J. H. Harlow, R. B. Smith, and P. L. Houser have nominated for 1956 the following:

Office	Nominee
President	Joseph Warren Barker
Vice-President (for two years)	Charles Edwin Crede, Region I
	Frank William Miller, Region III
	Albert Carl Pasini, Region V
	Bryan Towne McMinn Region VII
Directors	
Technical	Glenn Barton Warren (four years)
	J. F. Downie Smith (one year)
Codes and Standards	Louis F. Polk (four years)
	E. O. Bergman (two years)
Administrative	Joseph Pope (four years)

Biographical sketches of the candidates for office appear elsewhere in this issue of MECHANICAL ENGINEERING.

Inspection Trips and Committees

Inspection Trips

Some interesting and informative inspection trips were scheduled for the benefit of members and guests to research centers and industrial plants in the Boston area. The first trip on Tuesday took a group to the Quartermaster Research and Development Center, Natick, Mass. At this Center the group was shown facilities for studying soldier's requirements and test equipment under simulated environment. A high light of the tour was the Climatic Chambers in which it is possible to simulate temperatures, precipitation, and wind velocities characteristic of any climate in the world.

An informal tour of the research laboratories of Arthur D. Little, Inc., in West Cambridge, was scheduled on Wednesday. Among the exhibits shown were a magnetic refrigerator which produces continuous temperatures of $1/4$ deg absolute, a new type of blood-processing machine, and a trailer-mounted 2-ton-a-day liquid-oxygen plant.

On Thursday, members and guests toured the River Works plant of General Electric Company in West Lynn, Mass. The River Works is the headquarters for the Measurements and Industrial Products Division. Visitors were taken through several departments including the Lighting and Rectifier Department, the Aircraft Gas Turbine Division, the Synchronous and Specialty Motor and Generator Department, and the Medium Steam Turbine, Generator, and Gear Department.

A 35,000-ton hydraulic forging press was viewed on Friday at the Wyman-Gordon Company plant in Grafton, Mass. First of the heavy presses built under the USAF heavy-press program inaugurated in 1942, the press uses three 1500-hp pumps and has storage facilities for 125,000 gal of water.

Group of ASME members observing a sonic inspection operation during the Grafton plant trip held at the Wyman-Gordon Company of Worcester, Mass. This trip was one of the features of the Diamond Jubilee Semi-Annual Meeting. While at the Grafton plant, visitors were shown the Wyman-Gordon film "Light Metal Forgings," which highlights the forging operation on the 18,000-ton press.

Committees in Charge

The committees in charge of the arrangements for the Diamond Jubilee Semi-Annual Meeting included the following: *General Arrangements:* Alfred J. Ferretti, *chairman;* Alton Kirkpatrick, *vice-chairman;* Frederick Stearns, *secretary;* Frank Gunby, *Adviser;* Harold King, *Adviser;* William Alexander, Edgar MacNaughton, Warren Rohsenow, Ralph Sanborn, and Clarendon Southmayd; *Reception:* Kerr Atkinson, *chairman; Boston "Pops" Concert:* Edward Barry, *chairman; Clambake:* Ernest Mills, *chairman; Plant Trips:* Richard Bessom, *chairman; Technical Events:* Charles E. Crede, *chairman; Printing and Signs:* James E. Giles, Jr., *chairman; Publicity:* F. Everett Reed, Jr., *chairman; Finance:* William P. Saunier, *chairman; Registration:* Francis M. Staszesky, *chairman; Hotel:* Clarence Westaway, *chairman; Banquet:* Theodore N. Graser, *chairman; President's Luncheon:* Gerald White, *chairman; Ladies':* Mrs. Theodore N. Graser, *general chairman;* Mrs. Carl E. Anderson, *co-chairman;* Mrs. Charles E. Crede, *co-chairman;* Mrs. William P. Saunier, *Publicity;* Mrs. J. Dwight Bird and Mrs. R. G. Hastings, *Finances; Social Hour:* Mrs. Clarence J. Hunter, *chairman; Registrars:* Mrs. F. L. Archibald, *chairman;* Mrs. Frank Gunby, *co-chairman; Registration-Coffee Hour:* Mrs. C. E. Anderson, Mrs. E. H. Barry, and Mrs. T. N. Graser; *Boston Tour:* Mrs. J. P. Den Hartog, *chairman;* Mrs. John M. Totten, *co-chairman; Isabelle Gardner Museum Tour:* Mrs. C. Richard Soderberg, *chairman;* Mrs. O. S. Pike, *co-chairman; Cocktail Party, Banquet, and Dance:* Mrs. A. F. Downham, *chairman;* Mrs. M. W. Roberts, *co-chairman; Lexington, Concord, Wayside Inn Tour:* Mrs. Floyd Dedrick, *chairman* Mrs. George Saurwein, *co-chairman; North Shore Tour:* Mrs. A. J. Ferretti, *chairman;* Mrs. Harold King, *co-chairman; Plymouth Trip:* Mrs. Charles E. Crede, *chairman;* and Mrs. J Dwight Bird, *co-chairman.*

Women's Program

Women's-Program High Lights

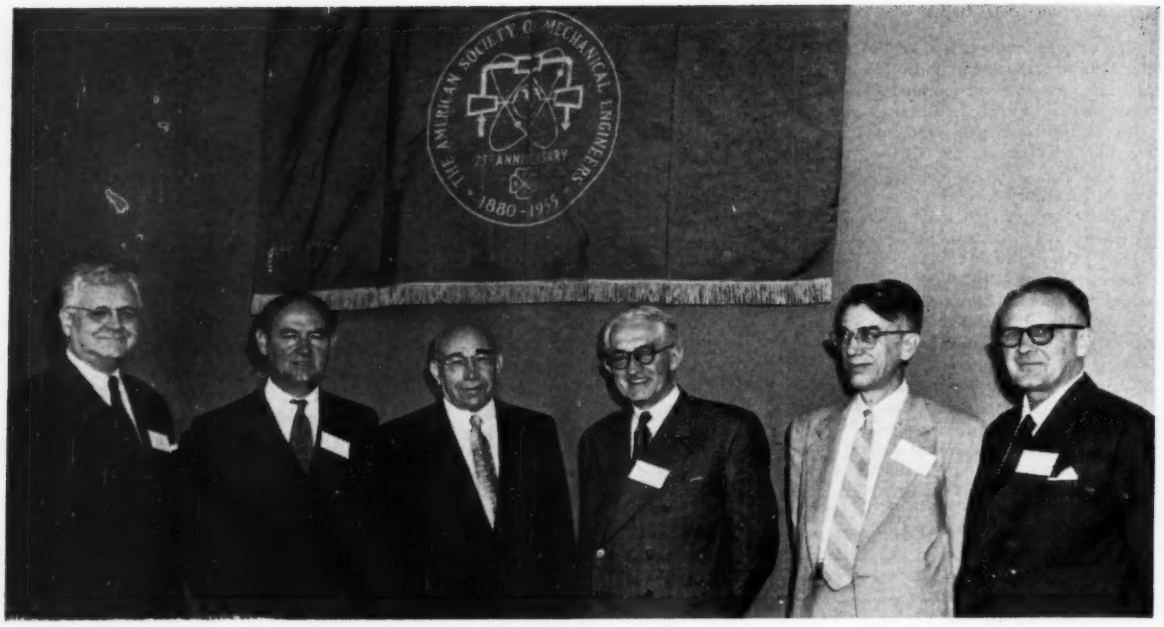
Tours of historic Boston and vicinity were a main feature of the women's program this year. The program was launched on Sunday afternoon with a social hour in the ballroom. On Monday the women joined the men for the President's Luncheon. In the afternoon a sight-seeing trip around Boston was arranged which included such interesting places as the Boston Common, historic Granary Burial Ground where many famous Bostonians are buried, the Old State House built in 1747, the Paul Revere House, the Old North Church, and the Bunker Hill Monument. At night members and their wives attended the Boston "Pops" Concert at Symphony Hall.

A tea and a tour of the Isabelle Gardner Museum were on the schedule on Tuesday. The Museum contains rare treasures from all over the world. The women joined the men for the evening program which included a cocktail party, a banquet, and a dance.

All-day tours of Lexington, Concord, and the Wayside Inn, and sight-seeing along the North Shore were conducted on Wednesday. On the Lexington-Concord route were seen the Lexington Green, Buckman Tavern where the Minute Men gathered, the Hancock-Clark House, and Concord Bridge. The North Shore tour included a view of such old New England towns as Marblehead, Salem, and Gloucester.

On Thurday afternoon a group went on a trip to historic Plymouth, with stops along the way at Adams Mansion and other points of interest. The day's program was topped off with a clambake in the evening, at Plymouth Harbor, enjoyed by members and their wives.

At the meeting of the International ASME-EIC Council on May 13 are shown, seated, *left to right,* D. M. Stephens, outgoing EIC president; Thompson Chandler, Vice-President, ASME, Region V; and R. E. Heartz, Hon. Mem. ASME, incoming EIC president. Standing in the same order are: K. H. Platt, assistant secretary, The Institution of Mechanical Engineers (Great Britain); Prof. W. G. McLean, Vice-President, ASME Region III; H. S. van Patter, Mem. ASME and EIC; G. N. Martin, Mem. ASME and EIC; J. G. Hall, Mem. ASME and EIC; D. G. Darling, chairman, Ontario Section, ASME; C. E. Davies, secretary, ASME; L. A. Wright, Mem. ASME, general secretary, EIC; and Colonel H. G. Thompson, Mem. ASME, executive assistant general secretary, EIC.



Leaders of the International Conference on Combustion shown at opening session on June 15 in Kresge Auditorium at the Massachusetts Institute of Technology, Cambridge, Mass. ***Left to right:*** **C. E. Davies, secretary, The American Society of Mechanical Engineers; Prof. O. A. Saunders, City & Guilds College, London, England; David W. R. Morgan, ASME President; P. L. Jones, President, The Institution of Mechanical Engineers of Great Britain; Prof. H. C. Hottel, M.I.T.; and Brian G. Robbins, secretary, IME.**

First International Conference on Combustion, ASME-IME Sponsored, a Huge Success

Excellent Meeting Attracts Large Audience, Honors Conferred, E. G. Bailey Speaker

THE first International Conference on Combustion, sponsored jointly by The Institution of Mechanical Engineers (British) and The American Society of Mechanical Engineers, was held at the Massachusetts Institute of Technology, Cambridge, Mass., June 15–17, with a registered attendance of more than four hundred, including about fifty from abroad. The keynote of the Conference was "to bridge the gap between theory and practice in different fields of engineering as applied to combustion."

Sessions were held in the new Kresge Auditorium Building and the technical program covered 45 papers by American, British, and Continental authors. It was divided into six sections, the first, or opening session, being of a more or less general scientific character; the second, devoted to boilers; the third, to industrial furnaces; the fourth, to internal-combustion engines; the fifth, to gas turbines; and the sixth, to holdover discussions which were precluded by lack of time at the other sessions.

Since there were from nine to ten papers at some of the sessions (none of which were held simultaneously), the British practice was followed of having reporters summarize groups of papers instead of presentation by the authors themselves. This plan permitted more time for discussion. At each session there were two reporters—one for the American papers and another for the British and Continental papers. Also, each session had two co-chairmen—one British and one American.

Prof. H. C. Hottel, Mem. ASME, of M.I.T., was chairman of the American Organizing Committee and Prof. O. A. Saunders of City & Guilds College, London, England, headed the British Organizing Committee.

From the social angle, a high spot of the Conference was a cocktail party and buffet supper attended by the guests from abroad and conference principals the evening before the meeting given by Professor and Mrs. Hottel at their attractive home near Cambridge. Other events of a social nature were attendance at the Boston "Pops" Concert on Wednesday evening and the banquet at the Faculty Club on Thursday evening.

President Morgan Opens Conference

At the opening session David W. R. Morgan, President of the ASME, prefaced his remarks by saying that he looked upon the British participation as a contribution of the IME to our 75th Anniversary. He then introduced Percy L. Jones, president of the IME, who reiterated the purpose of the Conference and observed that, despite the present widespread interest in nuclear energy, most of the subjects on the Conference program would continue to demand attention for a long time.

IME President Jones Honored

Speaking later at the banquet, at which time he was presented with honorary membership in the ASME by President Morgan, Mr. Jones stressed the close ties between the IME and the ASME and referred to periodic meetings of representatives of both bodies as members of an international organization of engineering societies of Western Europe and the United States, known as EUSEC. This organization is concerned not so much with material developments as it is with such matters as the engineers' contribution to advancement of civilization and social standards, conservation of natural resources, codes of ethics, engineering education and training, and our responsibilities to human welfare. The next meeting of EUSEC will be held at Copenhagen, Denmark, in September of this year.

E. G. Bailey Banquet Speaker

With Past-President R. J. S. Pigott acting as toastmaster, the principal address at the banquet was delivered by E. G. Bailey, past-president ASME, who talked on "The Economics of Combustion." Pointing out that practically every one of our many engineering activities is

related directly, or indirectly, to energy, he predicted that its use will undoubtedly continue to increase for many decades before the rate of increase begins to slow down to the inevitable pattern of the fundamental growth curve. In his opinion, the introduction of nuclear energy and the possibility of harnessing the sun are likely to add only an incremental portion to the total in the foreseeable future, and are not likely quickly to change the present trend of procuring additional energy from fuel.

Mr. Bailey's talk was replete with most interesting statistics such as:

The total cost of automobile fuel last year in the United States exceeded 13 billion dollars of which over three billion went for federal and state taxes. Furthermore, on the average, our cars operate on a load factor of about two per cent as compared with 60 to 80 per cent for central-electric-generating stations.

Fuel used to supply electric energy to our 51 million homes and other users with 410 trillion kwhr cost about 7¼ billion dollars at an average of 1.77 cents per kwhr. The total cost to the average residence is 2.69 cents per kwhr.

Fifty years ago about six pounds of coal were burned by central stations in the United States for each kwhr generated; this was reduced to two pounds by 1925; and last year the average was further reduced to one pound. This corresponded to an increase in over-all thermal efficiency from 4.5 to 28 per cent, although some of the latest coal-burning plants have attained as high as 38 per cent.

Comparing fuel-burning plants alone, central stations in Britain last year averaged 23.4 per cent thermal efficiency as compared with 26.5 per cent for investor-owned plants in the United States; and the most efficient plants operated at 30.9 and 38.5 per cent, respectively.

In the transportation field, the Btu cost of diesel fuel is now about three times the coal Btu cost, but the thermal efficiency of the diesel is more than four times that of the conventional coal-burning steam locomotive.

On the basis of last year's electric-utility output in this country of some 410 trillion kwhr, with a sales revenue of over 9 billion dollars, the fuel cost on the 75 per cent generated in steam plants was around a billion dollars, or about 16 per cent of the total sales value.

Opening Session

The three papers at this session were presented by the authors instead of by reporters. The first, on "The Chemistry and Physics of Combustion," was in two parts, namely, (1) "The Chemical Aspects," by Sir Alfred Egerton of the Imperial College of Science and Technology, London, England, and (2) "Chemical and Physical Factors Controlling the Rate of Combustion," by Prof. O. A. Saunders and Prof. D. B. Spalding, both of City & Guilds College, London. It discussed such matters as the oxidation of hydrogen, oxidation of industrial gases, knock, flame combustion, premixed flames, flame and radiation, diffusion flames, reaction rates for solid-fuel combustion, effect of pressure and of air-fuel ratio on reaction rate, inflammability limits, spontaneous ignition, propagating flames, combustion stability, and extinction by excessive supply as well as excessive heat loss.

Bernard Lewis, president, and Guenther von Elbe, vice-president, of Combustion and Explosives Research, Inc., Pittsburgh, Pa., were co-authors of the second paper, entitled "Scientific Principles of Combustion and Their Application." Briefly stated, this covered a survey of present knowledge of scientific principles in the field of combustion processes, including chemical kinetics as a means of understanding the chemical changes occurring during combustion, the propagation and structure of combustion waves as a means of understanding processes of ignition and flame stabilization, and turbulent-flame propagation as a means of understanding the processes occurring in combustion chambers. Application of such principles to combustion practice was considered, and it was noted that, although only minor applications have heretofore been made in the development of technical combustion processes, newer developments can be expected to make increasing use of the knowledge that has developed in the past decade and that is still rapidly growing.

Appraisal of Combustion Research

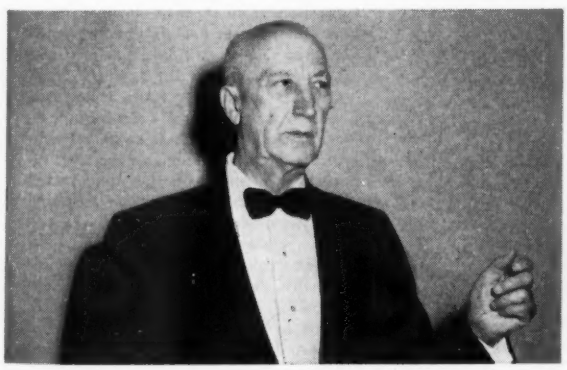
The third paper at this session was "An Appraisal of Combustion Research," by Ralph A. Sherman and William T. Reid, both of Battelle Memorial Institute, Columbus, Ohio. The authors reviewed research in combustion with the objective of appraising its effect on today's practice in the utilization of fuels, and an extensive reference appendix was included. The authors' conclusion, after considerable study, was that engineering research and development have played greater parts in the advances that have been made than has fundamental research. The lesson to be drawn from the study is not that there should be less fundamental research, but that there should be improved understanding between the research worker and the engineer who must apply the results.

Technical Sessions

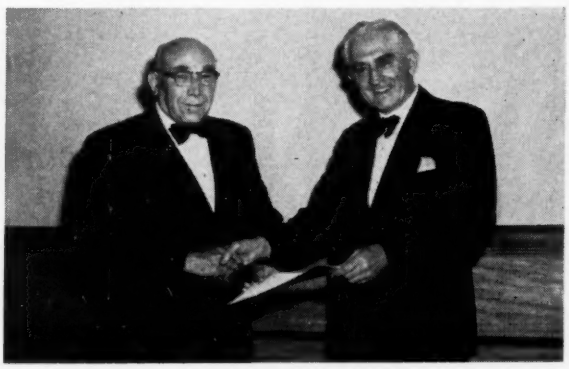
At the session on boilers there were four American papers dealing with furnace design, operation and instrumentation, the prevention of air pollution from refinery furnaces, and with firing methods available for burning the more common fuels. These were reported in summary by J. C. McCabe.

The British and Continental papers at this session, reported by W. F. C. Schaap, discussed boiler availability; liquid-fuel firing; the combustion of pulverized fuel for steam generation; cyclone firing in Germany; and spreader stokers.

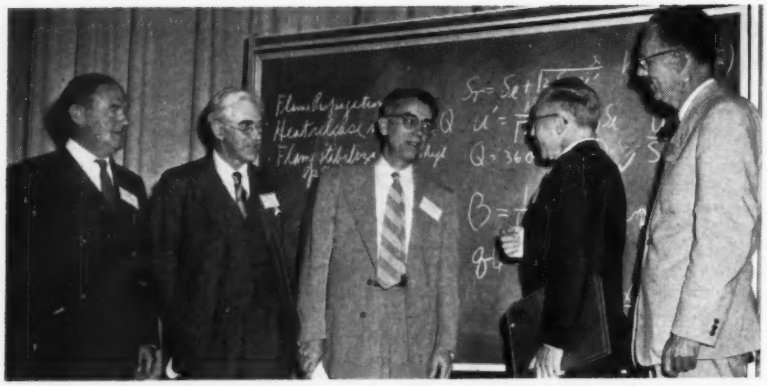
Industrial furnaces was the subject of a group of 11 papers on Thursday morning. Walter S. Anderson reported the American papers and J. H. Chesters the foreign papers. The former dealt with gas as a source of protective atmosphere; combustion in industrial furnaces; instruments as applied to product improvement in steel furnaces; instrumentation of process tubular heaters; and the use of high-temperature gaseous jets in some manufacturing processes. The latter group dealt with combustion and heat transfer in open-hearth furnaces, oil burners in open-hearth furnaces, melting in cupolas and the utilization



E. G. Bailey, past-president and Hon. Mem. ASME, consultant and director, The Babcock & Wilcox Company, New York City, delivering banquet address on "Economics of Combustion." Banquet was held at the M.I.T. Faculty Club in the Alfred P. Sloan Building on Thursday, June 16.



David W. R. Morgan, *left*, ASME President, confers honorary membership in ASME on Percy L. Jones, *right*, President, The Institution of Mechanical Engineers of Great Britain. Honor was conferred during banquet on June 16 at M.I.T. Faculty Club in Alfred P. Sloan Building, Cambridge, Mass.



Participants at the opening session of the International Conference on Combustion on June 15, at Kresge Auditorium, Massachusetts Institute of Technology, Cambridge, Mass. *Left to right:* Prof. O. A. Saunders, City & Guilds College, London, England, co-chairman of the Conference; Sir Alfred Egerton, Imperial College of Science and Technology, London, England; Prof. Hoyt C. Hottel, M.I.T., co-chairman of the Conference; Bernard Lewis, president, Combustion and Explosives Research, Inc., Pittsburgh, Pa.; and William T. Reid, assistant technical director, Battelle Memorial Institute, Columbus, Ohio.

of cupola-waste gases, combustion and heat transfer in glass tanks, and combustion in continuous reheat furnaces.

Internal-Combustion Engines

Internal-combustion engines was the topic of the Thursday afternoon session at which Prof. Martin A. Elliott reported on the American papers and J. F. Alcock, those from abroad. The American papers discussed high-compression turbocharged spark-igniton gas engines; heat-release rates in hydrocarbon combustion; and surface ignition in a motored engine. The British and Continental papers touched upon combustion in large diesels, in petrol (gasoline) engines, and in dual-fuel engines, as well as in diesels with divided combustion chambers. With L. N. Rowley reporting American papers and J. S. Clarke the foreign papers at the Gas Turbine Session on the last day of the Conference, a variety of subjects were covered and the numerous discussions attested to the popularity and wide interest in gas turbines. The titles included "Application of Electronic Probes to Measurements in Turbulent Flames"; "Iridium Versus Iridium-Rhodium Thermocouples for Gas-Temperature Measurements up to 3500 F"; "Coal-Firing for the Open-Cycle Gas Turbine"; "Combustion of Blast-Furnace Gas in Gas Turbines"; "The Relation of Specific Heat Release to Pressure Drop in the Aero-Gas-Turbine Combustion Chambers"; "Combustion Chambers and Control of the Temperature at Which They Operate"; "The Use of Solid Fuel in the Gas Turbine"; "Combustion of Residual Fuel in Gas Turbines"; "Operating Experience With Combustion Equipment in Industrial Gas Turbines"; and "Application of Research to Gas-Turbine Combustion Problems."

At the conclusion of the Conference on Friday, following brief remarks by President Jones, Professor Saunders, and Professor Hottel, President Morgan thanked the various chairmen and reporters and observed that the meeting had pointed up the need of co-operation between the scientist, the engineer, the metallurgist, the chemist, and the manufacturer. He referred to the phenominal development in jet engines and gas turbines but cautioned that we should be concerned with the enormous amounts of stragetic materials and valuable alloys that are consumed in attaining the objective. He concluded by offering a resolution of appreciation to the officers and staff of the Massachusetts Institute of Technology for the facilities extended to the Conference.

Head-table group at banquet on June 16 during International Combustion Conference held at the Massachusetts Institute of Technology, Cambridge, Mass. Seated, *left to right,* are Mrs. Hartley, Mrs. Hottel, Mrs. Jones, Mrs. Morgan, Lady Egerton, Miss Saunders. Men standing, *left to right,* Sir Alfred Egerton, C. E. Davies, President Morgan, A. D. Blake, E. G. Bailey, R. J. S. Pigott, President Jones, Dr. Watson, Mr. Hartley, Professor Saunders, Professor Hottel, Kenneth H. Platt, Brian Robbins, Secretary, IME.

Solid and Fluid-Mechanics Conference

A JOINT meeting of the Second Midwestern Conference on Solid Mechanics and the Fourth Midwestern Conference on Fluid Mechanics will be held at Purdue University, West Lafayette, Ind., on Sept. 8, 9, and 10, 1955.

Papers have been submitted for each of these conferences and are now being reviewed for acceptance for presentation and publication.

These conferences have been well attended in the past and have proved to be valuable contributions in the fields of solid and fluid mechanics. Purdue University extends a hearty invitation to all interested scientists and engineers.

ASME Exhibit at National Machine Tool Show

ASME members attending the National Machine Tool Builders Show are cordially invited to visit the ASME booth at the show which will be held at the International Amphitheatre in the Stock Yards, Chicago, Ill., Sept. 6–17, 1955, from 10:00 a.m. to 5:30 p.m. daily.

In addition to the valuable information to be derived from the show, ASME members and guests will enjoy visiting the ASME booth because here, too, there will be an extensive exhibit of ASME publications which contain important information of interest to the users of all types of machine tools, as well as to the manufacturers thereof.

Clover Club—The ASME Clover Club, named in honor of the famous ASME four-leaf clover badge, is where members and their friends will meet for an opportunity to relax and enjoy refreshments after the strenuous experience of visiting a show of this magnitude. The ASME members and staff members will be on hand to assist the visitors in every way they can.

The exhibit that ASME is preparing for this show, the first ever at a Machine Tool Builders Show, will be both useful and attractive.

It is hoped that all ASME members who serve on Society committees concerned with machine tools will make it a point of attending the show and registering at the ASME booth.

ASME OFFICERS *Nominated for* 1955-1956

Joseph Warren Barker
Nominated for President

DURING the Diamond Jubilee Semi-Annual Meeting of The American Society of Mechanical Engineers in Boston, Mass., June 19–23, 1955, Joseph Warren Barker, chairman of the board and president of Research Corporation, a nonprofit foundation, and chairman of the board of the wholly owned subsidiary, Research-Cottrell, Inc., New York, N. Y., was nominated by the National Nominating Committee for the office of President of the Society for the year 1955–1956.

Regional Vice-Presidents named by the Committee to serve for a two-year term on the Council of ASME were Charles Edwin Crede, Watertown, Mass., Region I; Frank William Miller, Philadelphia, Pa., Region III; Albert Carl Pasini, Detroit, Mich., Region V; and Bryan Towne McMinn, Seattle, Wash., Region VII.

Directors named by the Committee were the following: *Technical*, Glenn Barton Warren, Schenectady, N. Y., four years; J. F. Downie Smith, Ames, Iowa, one year; *Codes and Standards*, Louis F. Polk, Dayton, Ohio, four years; E. O. Bergman, Alhambra, Calif., two years; *Administrative*, Joseph Pope, four years.

Members of the Committee making the nominations were L. E. Seeley, representing Region I; P. C. Osterman, Region II; Guerard Mackey, Region III; R. C. Robertson, Region IV; E. W. Allardt, Region V; J. G. VanVleet, Region VI; B. G. Dick, Region VII; and R. B. Stewart, Region VIII. Members of the Committee appointed by Council were R. B. Smith, *Technical;* P. L. Houser, *Codes and Standards;* and J. H. Harlow, *Administrative*.

Election of ASME officers for 1955–1956 will be held by letter ballot for the entire membership, closing Sept. 29, 1955.

Biographical sketches of the nominees follow on the succeeding pages.

Nominated for President 1955-1956

Joseph Warren Barker

JOSEPH WARREN BARKER, who has been nominated to serve for one year as President of The American Society of Mechanical Engineers, is Chairman of the Board and President of Research Corporation, a nonprofit foundation, and Chairman of the Board of the wholly owned subsidiary, Research-Cottrell, Inc., New York, N. Y. He is also the current (1954–1955) president of the Society of the Sigma Xi, national scientific association.

Mr. Barker, who lives in New Rochelle, N. Y., came to Research Corporation in 1945 as acting president and was elected President in 1946 and President and Chairman of the Board in 1947.

He was born in Lawrence, Mass., June 17, 1891. After attending the University of Chicago, where he studied in the physical sciences under Prof. Robert Andrews Millikan, he was graduated from the Massachusetts Institute of Technology in 1916 with an electrical-engineering degree. Upon graduation he was commissioned a Second Lieutenant in the Army and from 1918 to 1922 served in the American Expeditionary Forces and the American Forces in Germany.

Following his resignation from the Regular Army in 1925, he spent his career in educational work, starting as an associate professor of electrical engineering at the Massachusetts Institute of Technology. From M.I.T. he went to Lehigh University in 1929 as professor and head of the department of electrical engineering, and then to Columbia University in 1930 as dean of engineering. He resigned his deanship in 1946 to become President of Research Corporation.

From 1941 to 1945 Mr. Barker was on leave of absence from Columbia to serve as special assistant to the Secretary of the Navy. During this period he was reponsible for policy of all educational and training programs, particularly the highly successful V-12 Naval College Training Program. He also served as the representative of the Secretary of the Navy on the War Manpower Commission, as co-ordinator of training liaison for the Secretary of the Navy, and as a member of the Joint Army-Navy Personnel Board from the date of its inception in May, 1942, until he left the Navy in 1945.

Mr. Barker joined The American Society of Mechanical Engineers as a member in 1930. He has served the Society as a member of the Meetings Committee, 1947–1949; as chairman of that committee, 1952–1953; as a member of the Board on Technology, 1947–1948 and 1952–1955; as a member of the Organization Committee, 1950–1955, and chairman, 1954–1955; as a member of the Public Relations Committee, 1948–1949, and as an advisory member of Executive Committee of Council, 1954 to date. Outside the Society he has served on many committees, and as vice-president, district 3, of the American Institute of Electrical Engineers, and as vice-president and president of the Illuminating Engineering Society.

He is also an active member of The Engineering Foundation Board, serving as its chairman from 1953 to date. From 1950–1952 Mr. Barker was a member of the Committee on Technical Assistance of the International Relations Commission of the Engineers Joint Council. He is also a member of the ASCE and of the AIME.

A registered professional engineer in New York State since 1931, he is a member of the Newcomen Society of England; The Engineers' Club, New York; The Century Association, New York; The University Club of New York; the Columbia University Club, New York; the Westchester Country Club, Rye, N. Y., and the Cosmos Club of Washington, D. C. He is a member of the advisory committee of The Chase Manhattan Bank, Grand Central Branch, and a director of National Malleable and Steel Castings Company. He has been a member of the Advisory Committee of the United States Coast Guard Academy since 1934 and served as its chairman from 1952–1955. He served as a member of the board of trustees of the Educational Testing Service for a five-year term. During the full term he was chairman of the Finance Committee and a member of the Executive Committee. He was also a member of the board of directors of The Dorr Company, 1952–1954. He is president of The Society of the Sigma Xi and has just completed a term as chairman of The Scientific Research Society of America.

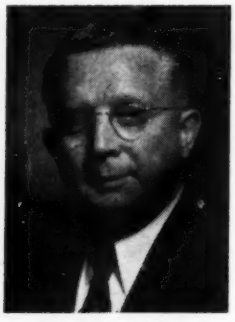
As a representative of the United States, Mr. Barker attended the Organization for European Economic Co-Operation Conference on Research Administration held at the University of Nancy, France, in 1954. At this Conference he was a speaker on the subject of university patents and acted as a consultant to the Office for European Economic Co-Operation.

Mr. Barker is a member of Sigma Xi, Tau Beta Pi, Theta Tau, and Phi Kappa Sigma. He is a vestryman of Trinity Church, New York City, and chairman of their Committee on Fabric of the Church and its Chapels.

He received honorary degrees of doctor of engineering from Case School of Applied Science in 1942 and the University of Rochester in 1944; doctor of laws from Bucknell University in 1940 and Union College in 1944; doctor of science from Northeastern University in 1940 and Ripon College in 1953; and doctor of humane letters from Muhlenberg College in 1945. He was presented the Navy Distinguished Civilian Service Award in 1945.

Nominated for Regional Vice-President To Serve Two-Year Term

Charles E. Crede



Frank W. Miller

Charles E. Crede

CHARLES EDWIN CREDE, who has been nominated from Region I to serve for two years as Regional Vice-President of The American Society of Mechanical Engineers, was born May 4, 1913, at Wilkinsburg, Pa., and educated in the public schools of Wilkinsburg. He was graduated from Carnegie Institute of Technology in 1935 with the degree of bachelor of science in mechanical engineering. As a Tau Beta Pi Fellow, he attended the graduate school of the Massachusetts Institute of Technology and received the degree of master of science in mechanical engineering in 1936.

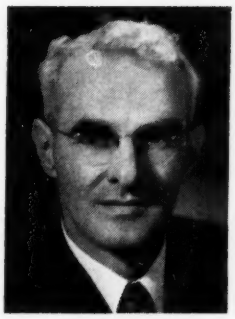
His initial industrial experience was gained first as development engineer and later as assistant to the patent counsel, Standard Railway Equipment Manufacturing Company, New Kensington, Pa., and Hammond, Ind. At the beginning of World War II he entered the employ of the Navy Department as a civilian engineer in the Electrical Section of the Bureau of Ships in Washington, D. C. He worked on the development of means to protect shipborne equipment from the severe shock encountered in Naval warfare. In 1944 he was transferred to the Naval Research Laboratory to take charge of the organization of the newly formed Shock and Vibration Division, and to serve as its administrative and technical head in carrying out a program of

research and testing. He held this position until the end of World War II.

He resigned from government service at the conclusion of World War II to enter private industry in the Boston area; accepted the position of vice-president and chief engineer of Barry Controls Incorporated, formerly The Barry Corporation, a concern engaged in the control of shock, vibration, and noise. This position he has held continuously to date, during which period the volume of business has increased 50 times. He holds a number of patents on railway-car structures and vibration-control devices. He has contributed articles to the journals of the engineering societies and to the technical press, and is the author of "Vibration and Shock Isolation" published by John Wiley and Sons, Inc., in 1951.

He has been a member of ASME since 1936 and has served the Society as chairman of the Boston Section, ASME; and is currently chairman of the Civic Affairs Committee of Region I and member of the General Committee of the Machine Design Division. He is also a member of the Society for Experimental Stress Analysis, The Acoustical Society of America, The American Society for Engineering Education, Tau Beta Pi, Pi Tau Sigma, Theta Tau, and Phi Kappa Phi.

A. C. Pasini



B. T. McMinn

Frank W. Miller

Frank William Miller, who has been nominated from Region III to serve as Regional Vice-President of The American Society of Mechanical Engineers, is vice-president in charge of manufacturing and a director of Yarnall-Waring Company in Philadelphia, Pa. He received his engineering training at Cornell University, being graduated in 1924 with an ME degree.

After graduation from high school he worked for two years in Harrisburg, Pa., with Appleby Bros. and Whitaker Company, a wholesale plumbing-supply company. Following this practical experience in an engineered products field he enlisted in the U. S. Army in 1918 and was sent to school for training, continuing at the school after the Armistice in 1918 and graduating in 1920. This was essentially two years of schooling in the arts and sciences.

Upon graduation from Cornell he was in the Engineering Trainee Test Course with Duquesne Light Company of Pittsburgh, Pa.

In 1926 he entered the test and service department of the Yarnall-Waring Company. Since that time he has made outstanding achievements in many phases of mechanical engineering and management. He joined Yarnall-Waring when it was a young company devoted largely to the manufacture of a single product—boiler blowoff valves—and advanced himself to positions of increasing engineering and management responsibility through notable contributions to the progressive development and growth of the company. His work over the earlier years involved contributions to and supervision of practically all phases of mechanical-engineering activity, including product development, application engineering, production, materials procurement, and inspection. This included such work as pioneering in designing for higher steam pressures and participating in engineering, installation, and research testing with a new 2500-psi research boiler which at the time was considered to be one of the highest pressure water-line boilers in existence (1931). After 1945 as works manager, and later in his present position, he made further contributions to the planning of plant extensions, improvement of manufacturing methods, streamlining of production flow through the plant, and standardization of rates and procedures. Mr. Miller has also done much to improve plant working conditions as well as working for the maintenance of good employee-management relations.

He has been active in ASME affairs since 1936. He was secretary of the Philadelphia Section Executive Committee in 1942–1943 and at the same time secretary of War Production Committee for the Philadelphia area. This included liaison work for several of the professional engineering societies in aiding production for the national emergency. He was chairman of the Philadelphia Section in 1944–1945. Paralleling this to some extent and following this activity, he served five years on the Constitution and By-Laws Committee, being chairman in 1948 and the representative of this committee on the Organization Committee.

He was Philadelphia Section Delegate to the Regional Agenda Committee Meeting in October, 1943, and chairman of this meeting the following year in Philadelphia (host section), and delegate to Regional Delegates Conference.

Mr. Miller was chairman of the Finance Committee for ASME Annual Meeting held in Atlantic City, N. J., in 1951 and a member of the General Committee. He was awarded Fellow Grade in the Society in 1953 and the same year was appointed secretary of Region III and has continued to serve in this capacity. In 1954 he was appointed to the Admissions Committee.

He has been active in committee work for the National Steam Specialty Club for several years.

Following the more active years with Philadelphia Section, ASME, he became chairman of the Finance Committee of the Engineers' Club of Philadelphia. Following this he became a director, then vice-president, and in 1951–1952 president. He has continued to be active in this engineering center of the rapidly growing Delaware Valley area.

Mr. Miller has been a member of the Program Committee of the Metal Manufacturers Association of Philadelphia since 1952.

He is a member of The Cornell Club of Philadelphia, The Cornell Society of Engineers, The American Society for Metals, and is a registered professional engineer in Pennsylvania. He is a member of the Newcomen Society in North America. He is the author of several papers and holds patents in the high-pressure steam-apparatus field.

A. C. Pasini

Albert Carl Pasini, who has been nominated from Region V to serve for two years as Regional Vice-President of The American Society of Mechanical Engineers, is assistant general superintendent of production, The Detroit Edison Company. He was born in Paterson, N. J. He was graduated from the University of Michigan in 1923, with a BS degree in mechanical engineering. He has been associated with The Detroit Edison Company since 1923.

Mr. Pasini has served in the Engineering Society of Detroit on numerous committees. He has been active in civic affairs as related to the Engineering Society of Detroit.

He has also served on several subcommittees of the Edison Electric Institute. During World War II he was fuel engineer on the fuel-efficiency council in the Solid Fuels Administration.

He joined the ASME in 1931. He has served as chairman, secretary, treasurer, and Program Committee chairman of the Detroit Section.

He has served the ASME as chairman of the National Agenda Committee, chairman of the National Membership Development Committee, and the Board on Technology. He is a former Vice-President and Director at Large of the Society. He is at present chairman of the newly formed Nuclear Engineering Division, and a member of the 75th Anniversary Committee.

Mr. Pasini is the author of several papers which have been published in the Transactions of the ASME. He has also published articles in various technical journals.

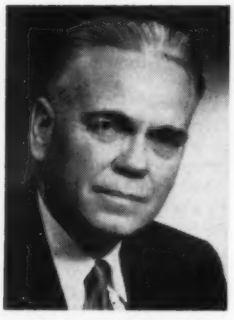
Mr. Pasini is a member of Theta Chi Fraternity, an honorary member of Pi Tau Sigma, and a member of Tau Beta Pi.

He is also a member of the Society of American Military Engineers, American Ordnance Association, National Society of Professional Engineers, and a registered professional engineer in the State of Michigan.

B. T. McMinn

BRYAN TOWNE MCMINN, who has been nominated from Region VII to serve for two years as Regional Vice-President of The American Society of Mechanical Engineers, was born in Superior, Wis., Feb. 29, 1896. In 1918 he was graduated from the Oregon State College with a BS(ME) degree. Eight years later he received his master's in mechanical engineering from the University of Washington and in 1931 an ME degree from the same institution. While his career has been in the field of engineering education he has done much consulting work in stress analysis, materials of engineering, and refrigeration. From 1919 to 1920 he was engaged as a designer with Meese & Gottfried Company (now Link-Belt) of San Francisco. Later in 1920 he was appointed to the engineering faculty of the University of Washington where he has remained and is serving currently as professor and head of the mechanical-engineering department. Several of his papers have been published in the professional journals; he has delivered numerous addresses before engineering societies; and was a member of the Joint Committee of Local Sections of Founder Societies which helped bring about the Washington State Engineers License Law. His research work with Prof. R. H. G. Edmonds led to the development of a polariscope and related equipment for stress studies for the photoelasticity method believed to be the second unit in the United States. Research in this field has been continued since 1924. His work has led to the development of dynamometer-test equipment for four-wheel mechanical brakes, in 1923; the four and eight-harness looms for operation by the blind; and various visual-aid devices for use in instruction, such as refrigeration apparatus with glass evaporator and condenser, and critical-temperature and slip-band demonstrators. He has been a member of ASME since 1915, when he joined as a student. In 1930–1931 he was secretary of the Western Washington Section; in 1938, 1939, and 1944 he was chairman of the Section. He was delegate to several conferences of Group Delegates and in 1944 he was chairman of Group VII Conference. He was a member of the 1939 National Nominating Committee. In 1952 he represented the ASME President at the annual meeting of The Engineering Institute of Canada held in Vancouver, B. C.

Nominated for Director—Technical, Codes and Standards, Administrative



Glenn B. Warren

J. F. Downie Smith

Glenn B. Warren

GLENN BARTON WARREN, who has been nominated to serve as a Technical Director of The American Society of Mechanical Engineers for a four-year term, was born in Rich Hill, Mo., Feb. 28, 1898. He was graduated from the University of Wisconsin in 1919 with a BS(ME) degree; in 1924 he received an ME degree. Since 1919 he has been in the employ of the General Electric Company, successively holding positions of increasing responsibility for development and design engineering and general management of steam and gas turbine, generator, and gear-product lines. Presently he is vice-president and general manager of the Turbine Division of the company. He is the author of numerous technical papers published in the leading engineering journals and holds 47 patents in the field of steam and gas turbines. In 1948 he received a Certificate of Commendation from the U. S. Navy for outstanding service during World War II. He was awarded the ASME Medal in 1951 as "Engineer and Leader in the Science and Art of Turbine Design." The following year the University of Wisconsin presented him with a citation for engineering achievement. Since 1941 he has been a member of the Schenectady Chamber of Commerce. From 1944–1946 he was secretary of the board of directors of the Schenectady Bureau of Municipal Research; he has been a member of the Bureau since 1943. He joined ASME in 1924 and in 1928 served as chairman of the Schenectady Section. He is an active participant in local Society activities and his contributions to the Society on a national plane include his work on the Meetings Committee, 1945–1950; member of the Power Division Executive Committee, 1946–1951, chairman in 1951; Power Division Honors Committee, 1952; Organization Committee, 1952; and in 1954 his appointment to the 75th Anniversary Committee. He has been a Fellow ASME since 1946.

J. F. Downie Smith

J. F. DOWNIE SMITH, who has been nomiated to serve as a Technical Director of The American Society of Mechanical Engineers for a one-year term, was born in Scotland in 1902.

A background of industrial and academic experience in engineering was brought to Iowa State College in 1947 by J. F. Downie Smith when he became dean of the Division of Engineering, and director of the Engineering Experiment Station and of the Engineering Extension Service.

In 1923 he received a diploma from the Royal Technical College, Glasgow, Scotland, with special distinction, and also received his bachelor of science degree with special distinction from Glasgow University that same year. Other degrees he has been awarded include an MS from the Georgia School of Technology, 1925; ME, Virginia Polytechnic Institute, 1928; SM, Graduate School of Engineering, Harvard University, 1930; and ScD, also from Harvard in 1933.

After serving an apprenticeship as an engineer with the Albion Motor Car Company in Scotland, he worked as a machine and tool designer until he entered the teaching field. For two years he was assistant professor of experimental engineering at Georgia Tech, two years as assistant professor of engineering drawing at V.P.I., and eight years at Harvard Graduate School of Engineering as a national research fellow and as an instructor.

He then decided to enter industry and for four years was executive engineer of research and development for the Budd Manufacturing Company. For the next three years he was chief engineer of the aircraft section of the United Shoe Machinery Corporation, and for three years served as head of the engineering department of that company. In 1947 he resigned to go to Iowa State.

Dr. Smith's activities in The American Society of Mechanical Engineers include past-chairmanship and research secretary of the Rubber and Plastics Division; past-chairman of the Machine Design Division; past-chairman of the Research Committee; and past-chairman of the Committee on Thermophysical Properties; he is a past-member of the Board on Technology and of the Power Test Codes Committee. He is a Fellow of the Society.

He was a member of the board of the Engineering Research Foundation and a member

of the Research Procedure Committee of the Foundation.

In the American Society for Engineering Education he was a member of the Executive Committee of the Engineering Colleges Administrative Council, is chairman of the Board of Directors of the Committee on Relations With Industry; and was a member of the Committee on Improvement of Teaching.

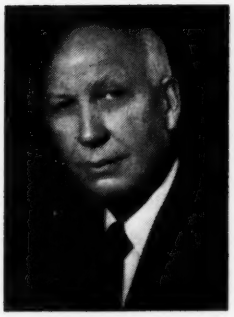
In the Association of Land Grant Colleges and Universities, he has served as chairman of the Engineering Experiment Station Section of the Engineering Division.

Honor societies to which Dr. Smith belongs include Phi Kappa Phi, Tau Beta Pi, Pi Tau Sigma, and Sigma Xi.

Dr. Smith has obtained patents on several inventions and has others pending. He has written a large number of articles for engineering magazines and gives many talks to engineering societies.

Louis Polk

Elmer O. Bergman



Joseph Pope

Louis Polk

Louis Polk, who has been nominated to serve as a Codes and Standards Director of The American Society of Mechanical Engineers for a four-year term, is chairman and president of the Sheffield Corporation, Dayton, Ohio.

The company is engaged in producing precision measuring instruments and machine tools, gages, automatic gaging machines, threading and cutting tools, and contract manufacturing and engineering services. He is also chairman of several Sheffield subsidiaries, including Sheffield Corporation of Australia, Pty. Ltd., with plant and general offices at Melbourne, and the Threadwell Tap & Die Company, Greenfield, Mass.

His other activities include: Director of the Winters National Bank & Trust Company, member of Associate Board of Lay Trustees of the University of Dayton, president of Pirm, Inc., and chairman of the board of directors of the State Fidelity Federal Savings & Loan Association, all of Dayton. He is a national director and vice-president in charge of technical divisions and committees of the American Ordnance Association, as well as chairman of the Dimensional Standards and Metrology Division, and a director and immediate past-president of the Cincinnati Post, A.O.A. He is president of The Sheffield Foundation and a member of the board of directors of the Salvation Army of Dayton.

In addition to the activities already described, Mr. Polk is a director and first vice-president of the National Machine Tool Builders' Association, a member of The American Society of Mechanical Engineers since 1943, Society of Automotive Engineers, American Society of Tool Engineers, American Gage Design Committee of the National Bureau of Standards, and a charter member of the Air Force League. He is a permanent director of the Research Fund of the American Society of Tool Engineers.

He is the recipient of the 1955 John Pottinger Award, presented by the Dayton Chamber of Commerce World Trade Committee for meritorious contributions toward the advancement of good will through world trade. The Army Ordnance Gold Medal was presented to Mr. Polk in 1945 for "Outstanding Service." The Navy Department awarded Mr. Polk a civilian citation in 1945. That same year, Robert Patterson, Secretary of War, awarded Mr. Polk a civilian citation "for outstanding assistance rendered to the Ordnance Department in time of war."

His membership in clubs includes the Engineers, Bicycle, Moraine Country Club, Miami Valley Hunt and Polo Clubs of Dayton, Metropolitan and Deke Clubs of New York, N. Y., Metropolitan Club of Washington, D. C., Queen City Club of Cincinnati, Detroit (Mich.) Athletic Club, Bloomfield Hills Country Club, Bloomfield Hills, Mich., and Union League Club of Chicago, Ill.

Elmer O. Bergman

E. O. Bergman, who has been nominated to serve as a Codes and Standards Director of The American Society of Mechanical Engineers for a two-year term, is staff-consultant with C. F. Braun & Company, Alhambra, Calif. His principal field of work is stress analysis on structures, pressure vessels, piping, and rigging. A native of Nebraska, he was born in Kimball in 1892. He has received degrees from three educational institutions, which include: BA, Creighton University, 1920; BS, 1925, MS, 1926, and CE, 1932, University of Colorado; and PhD, Stanford University, 1938. From 1924 to 1937 he taught civil engineering and mechanics at the University of Colorado and during this same period he did summer engineering work for the American Bridge Company, Wyoming State Highway Department, and two United States Bureaus, Standards, in Washington, D. C., and Reclamation. He joined the Braun organization in 1938, following a year of study under Stephen P. Timoshenko, Hon. Mem. ASME. Mr. Bergman became a member of ASME in 1943. He serves the Society as a member of the ASME Boiler and Pressure Vessel Committee and of several of its subcommittees. He is Chairman of the Subcommittee on Unfired Pressure Vessels. He belongs to a number of other technical societies, including The Institution of Mechanical Engineers (London). He was an American delegate to the 1953 Paris, France, meeting of the International Standards Organization, TC 11 on Boilers. He is the author of "Manual on Theory of Elasticity" and "Calculation of Stress Data From Strain Measurement," and joint author of "Materials Testing."

Joseph Pope

Joseph Pope, who has been nominated to serve as an Administrative Director of The American Society of Mechanical Engineers for a four-year term, is in the employ of Stone & Webster Engineering Corporation. He is director, first vice-president, and consulting engineer. He is also director and vice-president of Stone & Webster Construction Company. He expects to retire shortly from these active affairs. He was graduted from the Massachusetts Institute of Technology in 1908 with an SB degree in naval architecture, going directly to the Quincy Yard of the Fore River Shipbuilding Company for a short time. Subsequently he worked three and a half years in power stations of Houghton County Traction Company and Baton Rouge Electric Company, both under operating control of Stone & Webster Management Association. He then, in 1912, became a member of the Betterment Division of Stone and Webster Engineering Corporation and, including a two-year interval, 1917–1918, as mechanical engineer for the American International Shipbuilding Corporation, itself allied to Stone & Webster, has completed nearly 47 years in the service of the latter organization. Returning to the direct activities of the Engineering Corporation in 1919, he rapidly rose to the position of steam research engineer, then consulting engineer. When in 1939 he became vice-president it was to be just five years before he would become first vice-president. His work has taken him to South America, Europe, and Turkey. He is the author of several technical papers, which have been published in various professional periodicals. He is a licensed professional engineer in the State of New York. In 1915 he joined ASME and was made a Fellow in 1952. In 1949 he was appointed honorary vice-president to represent the Society at the first Pan-American Engineering Congress held in Rio de Janeiro; three years later he represented the Society at the UPADI meeting in New Orleans, La. He was the 1954 chairman of the Finance Committee and is a member of the Advisory Committee to the National Exposition of Power and Mechanical Engineering. He was

appointed by Council as Director for 1955 as representative of the Administrative Committees, serving also on the Finance Committee, the Committee on Professional Practice of Consulting Engineering, and Special Committee on Study of Initiation Fees. He has also been active in the affairs of the Engineers Joint Council; serving as chairman of the Committee on International Relations, 1953–1955; vice-chairman of the delegation to the third UPADI convention in Brazil, and ASME representative on the EJC Finance Committee. Among his other professional-societies' affiliations, he is a member of the American Society of Naval Engineers and The Newcomen Society in North America.

Tenth Annual Petroleum Mechanical-Engineering Conference Program Announced

THE tenth annual Petroleum Mechanical-Engineering Conference will be held at the Roosevelt Hotel, New Orleans, La., September 25 through 28. The conference is sponsored by the Petroleum Division of The American Society of Mechanical Engineers with the cooperation of the New Orleans Section.

The available preprints of papers to be presented at the conference will be obtainable at conference headquarters in the Mardi Gras Room at the hotel.

Technical Program

In 17 sessions covering refining, production, transportation, and materials, more than 30 technical papers will be presented. The scheduled panel discussions will take up such questions as mechanics of bulk-oil measurement, ASME Unfired Pressure Vessel Code, and ASA B-31 Piping Code. Petroleum-production problems involved in offshore operations, pipe-line safety, and operations and design will also be discussed during the conference.

Orders for Technical Papers

ONLY copies of *numbered* ASME papers will be available. Some of these papers may not be available in time to permit your receiving them in advance of the conference. Your order will be mailed only when the complete order can be filled unless you request that all papers available ten days before the conference be mailed at that time. Please order only by paper *number;* otherwise the order will be returned. The final listing of available technical papers will be found in the issue of MECHANICAL ENGINEERING containing an account of the conference.

Copies of ASME papers may be obtained by writing to the ASME Order Department, 29 West 39th Street, New York 18, N. Y. Papers are priced at 25 cents each to members; 50 cents to nonmembers. Payment may be made by check, U. S. postage stamps, free coupons, or coupons which may be purchased from the Society. The coupons, in lots of ten, are $2 for members; $4 for nonmembers.

Copies of unnumbered papers, listed in the program, *are not available* because the review of these manuscripts had not been completed when the program went to press. The author's name and paper number will appear with paper title in the issue of MECHANICAL ENGINEERING containing an account of the conference, if the paper has been recommended for publication in pamphlet form.

Social Program

Leading off the social program on Sunday, September 25, is the "Get-Acquainted" Reception. It offers a lagniappe—not only will the conferees meet socially, but all will have the opportunity to "meet" New Orleans and Louisiana. Two interesting films, "The New New Orleans" and "The Good Neighbor Port," will be shown.

The featured speaker at the Welcoming Luncheon to be held on Monday is David W. R. Morgan, ASME President. His subject is "Future of Power Generation." The New Orleans Section has announced plans for a cocktail party from 5 p.m. to 7 p.m., to be held for the conferees at the Engineers Club of New Orleans at the De Soto Hotel.

What started out as an idea is today a high light of the Petroleum Conference—the Industry Luncheons. This year the Refining, Transportation, and Production Luncheons will afford the men in these fields an opportunity to meet one another and the working committees in each branch of their industry.

As always the high mark of the conference is the banquet, preceeded by a social hour. The program of the conference is completed with inspection trips and a Women's Program.

1956 Conference

The eleventh annual conference of the ASME Petroleum Division will be held in Dallas, Texas, at the Conrad Hilton Hotel, Sept. 23–27, 1956. The Division's host will be the ASME North Texas Section.

Registration

Sunday, September 25, 3:00 p.m. to 6:00 p.m.
Monday, September 26, 8:00 a.m. to 5:00 p.m.
Tuesday, September 27, 8:00 a.m. to 5:00 p.m.
Wednesday, September 28, 8:00 a.m. to 12:00 noon

Tentative Program

The tentative program of the tenth annual conference follows:

MONDAY, SEPTEMBER 26

8:00 a.m.

Registration

9:00 a.m.

Session (I)—Refining (I)

Current Development in Instrumentation by a Petro-Chemical Industry, by *E. E. Ludwig*, Dow Chemical Co.[1]

Future Trends in Automation, by *G. G. Gallagher* and *R. A. Robinson*, The Fluor Corp., Ltd.[1]

9:00 a.m.

Session (2)—Production (I)

Offshore Operations

Soil Mechanics as Applied to Mobile Drilling Units[1]

Mooring for Offshore Drilling Tender, by *R. K. Knapp*, Humble Oil & Refining Co.[1]

9:00 a.m.

Session (3)—Transportation (I)

Pipe-Line Safety

Practices in Displacing Liquid Hydrocarbon From Pipe Lines, by *S. C. Phelps*, Interstate Oil Pipe Line Co.[1]

Fire-Protection Equipment for Pipe-Line Stations and Terminals, by *A. L. Dunlap*, Tulane University[1]

9:00 a.m.

Session (4)—Materials (I)

Some Cases of Stress Due to Temperature Gradient, by *D. J. Bergman*, Universal Oil Products Co.[1]

Thermal-Cycling Test of a Hot Spot on a Vessel, by *P. N. Randall*, Standard Oil Co. (Indiana), and *H. A. Long*, Rand Corp. (Paper No. 55—PET-2)

High-Temperature Stability of Insulating and Refractory Castables in Reducing and Oxidizing Atmospheres, by *C. M. Vogrin* and *H. Heep*, The M. W. Kellogg Co.[1]

12:00 noon

Welcoming Luncheon

Presiding: *W. J. Verlander*, chairman, New Orleans Section, ASME

Introductions: *W. S. Nelson*, chairman, Local Conference Arrangements Committee

Welcome: *J. M. Todd*, past-president, ASME; past-president, Louisiana Engineering Society

Response: *C. H. Shumaker*, vice-president, Region VIII, ASME

Address: *David W. R. Morgan*, ASME President

Subject: **Future of Power Generation**

2:00 p.m.

Session (5)—Refining (II)

Fluid Coker—Mechanical-Design Aspects, by *E. J. Newchurch*, Esso Standard Oil Co., and *R. H. Maass*, Esso Research & Engineering Co.[1]

Orthoforming—An Application of the Fluid-Solids Technique to Catalytic Reforming, by *M. R. Smith*, The M. W. Kellogg Co.[1]

2:00 p.m.

Session (6)—Refining (III)

Tennessee Gas Transmission Turns the Key to Low-Temperature Operations, by *R. V. Mertz*, Tennessee Gas Transmission Co.[1]

[1] Preprints not available—see box on page 746.

Control of Pulsations in Piping Systems, by *Ned Moerke* and *C. Newman,* The Fluor Corp., Ltd.[1]

2:00 p.m.

Session (7)—Production (II)

Offshore Operations

Review of Weather Problems Encountered in Gulf Coast Offshore Petroleum Production During Years 1947–1955, by *A. H. Glenn,* A. H. Glenn Associates[1]

Offshore Construction, by *C. L. Graves,* J. Ray McDermott Co., Inc.[1]

2:00 p.m.

Session (8)—Transportation (II)

Panel Discussion: Mechanics of Bulk-Oil Measurement

Chairman: *W. H. Bruyere,* American Oil Pipe Line Co.

Vice-Chairman: *M. G. Trusdel,* The Texas Co.

Moderator: *A. H. Newberg,* Service Pipe Line Co.

Panel Members: *E. W. Jacobson,* Gulf Research & Development Co.; *M. L. Barrett, Jr.,* Shell Oil Co.; *J. H. Anderer,* Atlantic Refining Co.; *P. H. De Verter,* Humble Oil & Refining Co.; *R. C. Nicholson,* Shell Pipe Line Corp.; *H. E. Freeman,* Sun Pipe Line Co.; *R. H. Meyer,* Sinclair Pipe Line Co.; *B. Brannon,* Charles Martin & Co.; *L. S. Wrightsman,* Humble Pipe Line Co.

5:00 p.m.

Cocktail Party

All conference registrants and their guests are invited. Host is New Orleans Section, ASME, at the Engineers Club of New Orleans, De Soto Hotel

TUESDAY, SEPTEMBER 27

8:00 a.m.

Registration

9:00 a.m.

Session (9)—Refining (IV)

Research on Clad Steel at Elevated Temperatures, by *Rupen Eksergian,* The Franklin Institute, and *T. T. Watson,* Lukens Steel Co.[1]

A Pressure-Drop Correlation for Turbulent Two-Phase Flow of Gas-Liquid Mixtures in Horizontal Pipes, by *M. W. Martin* and *J. M. Chenoweth,* C. F. Braun & Co.[1]

High-Pressure Expansion-Joint Studies, by *S. R. Kleppe,* Esso Research & Development Co.

9:00 a.m.

Session (10)—Materials (II)—Transportation (III)

Yield and Bursting Characteristics of Heavy-Wall Cylinders, by *J. H. Faupel,* E. I. du Pont de Nemours & Co., Inc. (Paper No. 55—PET-1)

Consumable Insert Technique for Pipe Welding, by *R. D. Thomas, Jr.,* Arcos Corp. (Paper No. 55—PET-3)

Radiographic Examination of Lead Linings, by *William Skiba* and *V. P. Bracken,* Esso Standard Oil Co.[1]

12:00 noon

Industry Luncheons

Refining, Transportation, and Production Committees to hold separate luncheons. Members and those interested in the Petroleum Division Committees on Materials and Manufacturers are encouraged and invited to attend the industry luncheon which is of greatest interest to them.

2:00 p.m.

Session (11)—Refining (V)

Panel Discussion of ASME Unfired Pressure Vessel Code

Chairman: *E. O. Bergman,* C. F. Braun & Co.

Vice-Chairman: *K. P. Kammer,* New Orleans Public Service, Inc.

Panel Members: *F. S. G. Williams,* Member, Main ASME Boiler and Pressure Vessel Code Committee, Taylor Forge & Pipe Works; *N. J. Rees,* Socony Mobil Oil Co.; *C. E. Rawlins,* Member of ASME Subcommittee on Unfired Pressure Vessels, Phillips Petroleum Co.; *W. P. Kliment,* Member of ASME Subcommittee on Unfired Pressure Vessels, Crane Co.; *G. E. Fratcher,* Member of ASME Subcommittee on Unfired Pressure Vessels, A. O. Smith Corp.; *G. W. Watts,* Member of Joint API-ASME Code Committee on Unfired Pressure Vessels, Standard Oil Co. (Indiana); *R. M. Wilson, Jr.,* Member of ASME Subcommittee on Nonferrous Materials, The International Nickel Co.

2:00 p.m.

Session (12)—Production (III)

Operations and Design

Progress of Turbodrill Development in California, by *W. P. Postlewaite*[1]

Photoelasticity—A Useful Tool for the Oil-Tool Designer[1]

Tool-Joint Thread Lubricant, by *C. H. Dragert,* C. H. Dragert Co., Inc.[1]

2:00 p.m.

Session (13)—Transportation (IV)

Natural-Gasoline and Crude-Oil Handling

Volumetric Shrinkage Occurring in Blending Indirect Petroleum Products Such as Butane, Natural Gasoline, and Petroleum Distillates With Crudes, by *H. M. Childress* and *M. B. Grove,* Interstate Oil Pipe Line Co.[1]

Batching Natural Gasoline Through Crude-Oil Lines, by *C. N. Adams,* Phillips Pipe Line Co.[1]

6:00 p.m.

Social Hour

7:00 p.m.

Banquet

Presiding: *W. S. Nelson,* general chairman, Local Conference Arrangements Committee

Presentation of Student Award: *P. E. Frank,* chairman, Petroleum Division, ASME

WEDNESDAY, SEPTEMBER 28

8:00 a.m.

Registration

9:00 a.m.

Session (14)—Refining (VI)

Ebullition Cooling of Gas Engines, by *G. O. Bates, J. E. English,* and *G. M. Franklin,* Stanolind Oil & Gas Co.[1]

Operation of Compressor Cylinder Without Cooling Water, by *J. L. Gallagher* and *H. W. Evans,* Sinclair Oil & Gas Co.[1]

9:00 a.m.

Session (15)—Refining (VII)

Control of Refinery Maintenance and Construction Costs, by *E. C. Newton* and *M. A. Conetta,* The Atlantic Refining Co.

9:00 a.m.

Session (16)—Production (IV)

Production Equipment

Part 1—Effect on Thin-Walled Cylinders of Combined Loading From Tension and External Slip Compression[1]

Part 2—Application of the Problem of Oil-Well Casing Suspension, by *A. F. Rhodes,* McEvoy Co., and *J. C. Wilhoit,* The Rice Institute[1]

Hydraulic Pumping Units or an Engineering Look at the Big Ones, by *D. M. Jones,* Axelson Manufacturing Co., Division of U. S. Industries, Inc.[1]

2.00 p.m.

Session (17)—Refining (VIII)

Panel Discussion of ASA B31 Piping Code

Chairman: *F. S. G. Williams,* Taylor Forge & Pipe Works

Vice-Chairman: *L. J. Cucullu,* New Orleans Public Service Inc.

Panel Members: *W. P. Kliment,* Crane Co; *D. J. Bergman,* Universal Oil Products; *E. B. Stolle,* Midwest Piping Co., Inc.; *J. P. Mooney,* Humble Oil & Refining Co.; *R. G. Bateman,* The M. W. Kellogg Co.; *K. W. Haupt,* Pipe Fabrication Institute; *N. J. Rees,* Socony Mobil Oil Co.

THURSDAY, SEPTEMBER 29

9:00 a.m.

Inspection Trip

Assemble at University Place entrance of the Roosevelt Hotel to board buses. Proceed by bus and tour Shell Oil Company Refinery, including extensive 1954 addition of a catalytic-cracking unit with a fresh feed of 48,000 barrels per day and a gross feed of 72,000.

Leave Refinery and cross Bonnet Carrè Spillway and eat luncheon at Reserve, La. (included in cost of trip).

Visit Godchaux Sugar Refinery and Raw-Sugar Mill, latest in mechanical bulk handling.

Return to New Orleans along River Road passing some of the older plantation homes. Arrive at hotel about 4:00 p.m.

WOMEN'S PROGRAM

SUNDAY, SEPTEMBER 25

6:00 p.m. "Get-Acquainted" Reception

MONDAY, SEPTEMBER 26

12:30 p.m. Luncheon at Brennan's Restaurant

2:00 p.m. Walking Tour of French Quarter

5:00 p.m. Cocktail Party

TUESDAY, SEPTEMBER 27

6:00 p.m. Social Hour

7:00 p.m. Banquet

WEDNESDAY, SEPTEMBER 28

1:15 p.m. Trip on Yacht "Good Neighbor"

THURSDAY, SEPTEMBER 29

9:00 a.m. Tour of Shell Oil Company Refinery, luncheon at Reserve, and visit to Godchaux Sugar Refinery and Raw-Sugar Mill

Western Conference of ASME Applied Mechanics Division, Sept. 12–13

THE 1955 Western Conference of the Applied Mechanics Division's West Coast Committee of The American Society of Mechanical Engineers will be held at the U. S. Naval Postgraduate School in Monterey, Calif., Sept. 12–13, 1955. Papers in the following fields will be presented: Stress waves in spherical shells, sound waves in porous media, elasticity, large deflections of plates, nonlinear dynamics and nonlinear vibration, and aircraft-landing dynamics.

The American Society of Civil Engineers, Engineering Mechanics Division, is co-operating for the second year.

All interested ASME and ASCE members and others are invited to attend the conference.

Information regarding accommodations may be obtained from Prof. R. E. Newton, Committee on Arrangement, Department of Mechanical Engineering, U. S. Naval Postgraduate School, Monterey, Calif.

For information regarding the technical-papers program write to Prof. Walter W. Soroka, Secretary, West Coast Division, Division of Engineering Design, University of California, Berkeley 4, Calif.

ASME Applied Mechanics Division 19th National Conference Held at RPI

THE nineteenth national conference of the Applied Mechanics Division of The American Society of Mechanical Engineers was held at Rensselaer Polytechnic Institute, Troy, N. Y., June 16–18.

More than 200 attended the conference, which was held in Sage Lecture Hall situated on Rensselaer's beautiful campus. The technical program consisted of 29 papers presented by the leading authorities in the field at seven sessions. A complete set of the technical papers was presented to every registrant attending the conference.

The conferees were welcomed to Rensselaer by Livingston W. Houston, Mem. ASME, president of RPI. In his talk Dr. Houston related some of the history of the Institute and the contributions of the Van Rensselaer family who did so much for the Institute and the community.

At the banquet held on Friday evening, June 17, Carl H. Van Tassel, manager of the Knolls Atomic Power Laboratory, General Electric Company, Schenectady, N. Y., was the principal speaker. The subject of his talk was "A Is for Atom," a layman's account of developments in atomic energy.

The conference committee, under the able direction of Prof. R. H. Trathen, planned and carried out a most successful meeting. Mrs. W. P. Warren, director of social activities, arranged an enjoyable program for the women who attended. Reports indicated a pleasant time was enjoyed by all.

Availability List for 1955 National Applied Mechanics Conference Papers

THE papers in this list are available in separate copy form until April 1, 1956. Please order only by paper *number;* otherwise the order will be returned. Copies may be purchased from the ASME Order Department, 29 West 39th Street, New York 18, N. Y.; 25 cents per copy to ASME members; 50 cents to nonmembers. (See box on 746.)

Paper No.	*Title and Author*
55—APM-1	The Permanent Deflection of a Plastic Plate Under Blast Loading, by A. J. WANG
55—APM-2	Limits of Economy of Material in Plates, by H. G. HOPKINS and W. PRAGER
55—APM-3	The Extended Theory of the Viscous Vibration Damper, by F. M. LEWIS
55—APM-4	Thermal Stresses in Rectangular Strips—2, by J. S. BORN and G. HORVAY
55—APM-5	Experiments Concerning the Yield Surface and the Assumption of Linearity in the Plastic Stress-Strain Relations, by P. M. NAGHDI, J. C. ROWLEY, and C. W. BEADLE
55—APM-6	An Approximate Nonuniform Bending Theory and Its Application to the Swept-Plate Problem, by H. J. PLASS, JR.
55—APM-8	Combined Tension-Torsion Tests With Fixed Principal Directions, by E. A. DAVIS
55—APM-9	Simplified Formulas for Boundary-Value Problems of the Thin-Walled Circular Cylinder, by F. V. POHLE and S. V. NARDO
55—APM-10	Forced Vibrations of a Body on an Infinite Elastic Solid, by R. N. ARNOLD, G. N. BYCROFT, and G. B. WARBURTON
55—APM-11	On the Kinematic Path of Semitrailers, by G. A. G. FAZEKAS
55—APM-12	Stress Distribution in Square Plates With Hydrostatically Loaded Central Circular Holes, by A. J. DURELLI and J. BARRIAGE
55—APM-13	Free Vibrations of Thin Cylindrical Shells Having Finite Lengths With Freely Supported and Clamped Edges, by YI-YUAN YU
55—APM-14	Force at Point in the Interior of a Semi-Infinite Solid With Fixed Boundary, by LEIF RONGVED
55—APM-15	On the Nonlinear Oscillations of Visco-Elastic Plates, by A. CEMAL ERINGEN
55—APM-16	Aerodynamic Interference of Cascade Blades in Synchronized Oscillation, by CHIEH-CHIEN CHANG and WEN-HWA CHU
55—APM-17	Influence of Secondary Inertia Terms on Natural Frequencies of Rotating Beams, by J. L. BOGDANOFF
55—APM-18	Buckling of Laminated Columns, by L. G. CLARK
55—APM-19	Torsion of Circular Shafts of Variable Diameter, by M. M. ABBASSI
55—APM-20	Large Plastic Deformations of Circular Membranes, by N. A. WEIL and N. M. NEWMARK
55—APM-21	A Study of the Stability of Plane-Fluid Sheets, by W. W. HAGERTY and J. F. SHEA
55—APM-22	Integral Methods in Natural-Convection Flow, by SALOMON LEVY
55—APM-23	Nonlinear Dynamic Coupling in a Beam Vibration, by P. H. McDONALD, JR.
55—APM-24	Forced Vibration of a Clamped Rectangular Plate in Fluid Media, by GORDON C. K. YEH and JOHANN MARTINEK
55—APM-25	The Statistical Theory of Size and Shape Effects in Fatigue, by F. A. McCLINTOCK
55—APM-26	A Criterion for Minimum Scatter in Fatigue Testing, by F. A. McCLINTOCK
55—APM-27	Plastic Deformations of a Free Ring Under Concentrated Dynamic Loading, by R. H. OWENS and P. S. SYMONDS
55—APM-28	Some Solutions of the Timoshenko Beam Equations, by B. A. BOLEY and C. C. CHAO
55—APM-29	Thin Circular Conical Shells Under Arbitrary Loads, by N. J. HOFF

ASME OGP Conference Breaks All Records for Attendance

WITH military personnel attending in large numbers, it was appropriate that the twenty-seventh annual Conference and Exhibit of the Oil and Gas Power Division of The American Society of Mechanical Engineers should be based on the theme, "Oil and Gas Power for Defense." Held in the Hotel Statler, Washington, D. C., June 6–9, the meeting was an outstanding success.

Registrations totaled well over 650 which bettered the previous record for an OGP conference by more than a hundred. Technical sessions were unusually well attended. Papers were excellent in quality and broad in range of subjects covered and discussion was notably spirited.

Prominent among the wide variety of interests represented by those attending were sizable groups of consulting engineers; educators; Government agencies such as the Maritime Commission, Rural Electrification Administration, and the Bureau of Standards. Also largely represented were the oil companies, municipalities, and utilities.

The women attended in greater numbers than ever before and the entertainment arranged for them by the local Section was greatly enjoyed.

Welcome Luncheon

For several years the first day of the conference has been highlighted by a Welcome Luncheon. This affair breaks the ice, sets the keynote, and generally gets the meeting off to a favorable start.

Guests at the luncheon this year were pleased to witness the presentation of OGP citations for Outstanding Service to three widely known figures in the diesel field. They were E. C. Magdeberger, Mem. ASME, and Hugo Hass, both for many years with the Bureau of Ships, Navy Department, and Jean Sanchi, formerly with Nordberg Manufacturing Company. These citations were presented appropriately by Rear Admiral W. D. Leggett, Jr., U.S.N.

(Ret.), now with Alco Products Company, and for many years a staunch friend of the diesel industry.

Banquet

Another high light of the conference was the annual banquet, presided over by OGP Chairman, John A. Worthington, Mem. ASME, with Thomas E. Hughes, general manager, Cleveland Diesel Engine Division, General Motors Corporation, and president, Diesel Engine Manufacturers Association, acting as toastmaster.

Banquet guests were honored, by the presence of and remarks on ASME's Diamond Jubilee Anniversary, by D. W. R. Morgan, ASME President. Principal speaker was Arthur S. Fleming, Director of the Office of Defense Mobilization.

OGP Awards and Honors were presented by Chairman Sidney E. Miller, Mem. ASME, vice-president, American Bosch-Arma Corporation, to Wiley Sherwood for the Washington, D. C. Section, ASME, in recognition of its splendid handling of the conference arrangements; to Edward A. Sammis, Mem. ASME, Sperry Gyroscope Company; J. E. Hart, Kaiser Aluminum and Chemical Company; John C. Gibb, Mem. ASME, and Lewis F. Moody, Jr., Mem. ASME, Socony-Vacuum Oil Company; Carlton A. Chamberlain and George H. Bollman, Clark Bros. Company; T. H. Pofahl, Affiliate ASME, El Paso Natural Gas Company; and John A. Worthington, Mem. ASME, Koppers Company and retiring chairman of OGP.

Engineering Exhibit

Supplementing the technical program which was published in the May issue of MECHANICAL ENGINEERING was the Engineering Exhibit. The wide variety and attractiveness of the engine and equipment displays made this feature of the conference most interesting and educational. In turn, the exhibitors themselves were highly pleased with the caliber of individuals whom the conference afforded them an opportunity to contact.

ASME Boiler and Pressure Vessel Committee Meeting in San Francisco

THE 1955 out-of-town meeting of the ASME Boiler and Pressure Vessel Committee, held jointly with the National Board of Boiler and Pressure Vessel Inspectors, took place at the St. Francis Hotel, San Francisco, Calif., during the week of June 20.

The meeting opened on June 21 with a call to order by A. I. Snyder, Supervising Boiler Safety Engineer, and introductions by A. C. Blackman, Chief of Division of Industrial Safety, both of the State of California.

Representatives of Governor Goodwin J. Knight and of Mayor Elmer E. Robinson presented welcome and greetings.

Opening remarks were made by Ernest B. Webb, Director of Department of Industrial Relations, State of California; George S. Drysdale, chairman, ASME San Francisco Section; V. A. Peterson, vice-president ASME, Region VII; C. O. Myers, secretary-treasurer of the National Board of Boiler and Pressure Vessel Inspectors; Harry S. Brunson, chairman, National Board of Boiler and Pressure Vessel Inspectors; and H. E. Aldrich, vice-chairman of the ASME Boiler and Pressure Vessel Committee.

Notice was taken of the absence through illness of Mr. H. C. Boardman, chairman, ASME Boiler and Pressure Vessel Committee, and telegraphic greetings were sent him on behalf of the Committee and the National Board.

The remainder of the morning session was given over to technical papers delivered by R. A. Bowman, Bechtel Corporation; F. A. Lobel, vice-president of Cleaver Brooks Company; and J. P. Fanaritis, Struthers Wells Corporation.

A joint meeting of the ASME Boiler and Pressure Vessel Committee and the National Board of Boiler and Pressure Vessels on problems of mutual interest was held in the afternoon.

On Wednesday morning, June 22, an open panel session was held for free discussion on all Sections of the ASME Boiler and Pressure Vessel Code and in the afternoon open meetings of the following subcommittees of the Boiler and Pressure Vessel Committee were convened: (*a*) Subcommittee on Welding, (*b*) Subcommittee on Unfired Pressure Vessels, (*c*) Subcommittee on Power Boilers and the Subgroup on Fire Tube Boilers, and (*d*) Subcommittee on Heating Boilers.

National Board members and guests were noticeably impressed with the careful procedures and thorough manner in which suggested revisions to the Code were given consideration.

On Thursday, June 23, the regular open meeting of the Main Committee of the ASME Boiler and Pressure Vessel Committee was convened with a normal agenda of items for consideration. Members of the Conference Committee entered actively in these technical discussions on Code provisions and recommended actions.

All sessions were well attended, particularly the Panel Session with about 450 present, and participation by the members of the National Board and guests interested in ASME Code activities made the sessions extremely successful. The careful planning of the San Francisco Section of the ASME and the National Board of Boiler and Pressure Vessel Inspectors did much to insure the success of the meetings.

ASME Power Show in Chicago Expanding

EXHIBIT space in the Chicago Exposition of Power and Mechanical Engineering is being engaged at a rapid rate, and it appears that facilities available in a new area of the Chicago Coliseum may be required to meet the demand. The display will be held November 14 to 18, under the auspices of The American Society of Mechanical Engineers, as a part of the Diamond Jubilee Annual Meeting, which concludes the year-long celebration of the Society's 75th year.

Power Generation

The exposition will cover every phase of power generation and industrial use. Exhibits for which space already has been allotted embrace such widely assorted equipment as diesel engines, electric motors, oil purifiers, speed reducers, vibration control systems, electrical testing instruments, and instruments for the automatic control of apparatus ranging all the way from machine tools to entire plants for producing power or regulating its use in manufacturing.

Atomic-Power Section

As previously announced, an Atomic-Power Section will be a feature of the exposition, disclosing phases of the application of atomic energy to power of special interest to mechanical engineers. This new field poses many engineering problems that have never before been encountered, from the shielding of reactor plants and radioactive materials in transit and in use, to the conduct of many manufacturing operations by remote observation and control.

The Chicago Power Show is under the management of the International Exposition Company, 480 Lexington Avenue, New York 17, N. Y. E. K. Stevens is the exposition manager.

ASME Calendar of Coming Events

Sept. 12–14
West Coast Committee of the ASME Applied Mechanics Division, 1955 Western Conference on Applied Mechanics, U. S. Naval Post-Graduate School, Monterey, Calif.
(Final date for submitting papers was May 1, 1955)

Sept. 12–16
ASME Instruments and Regulators Division and Instrument Society of America Exhibit and Joint Conference, Los Angeles, Calif.
(Final date for submitting papers was May 1, 1955)

Sept. 25–28
ASME Petroleum-Mechanical Engineering Conference, Roosevelt Hotel, New Orleans, La.
(Final date for submitting papers was May 1, 1955)

Oct. 10–12
ASME-ASLE Second Lubrication Conference, Antlers Hotel, Indianapolis, Ind.
(Final date for submitting papers was June 1, 1955)

Oct. 19–20
ASME-AIME Joint Fuels Conference, Neil House, Columbus, Ohio
(Final date for submitting papers was June 1, 1955)

Nov. 13–18
ASME Diamond Jubilee Annual Meeting, Hotel Congress, Chicago, Ill.
(Final date for submitting papers was July 1, 1955)

Nov. 14–18
Exposition of Power and Mechanical Engineering, as part of ASME 75th Anniversary Annual Meeting, Coliseum, Chicago, Ill.

(Meetings of Other Societies will be listed in the September issue of MECHANICAL ENGINEERING.)

Policies on ASME Budget for 1955-1956

THE following statement of policies with the schedule of income and expense constitutes the Budget for 1955–1956.

1 A continuous effort will be made to collect dues.

2 No appropriation shall be made by Council without first referring back to the Finance Committee for recommendation. Before a liability is assumed the means for paying it shall be provided.

3 No new activity shall be undertaken without definitely showing that the funds required to support it will be available without decreasing the appropriations for existing essential activities, giving the consideration to the administrative expense that may be involved. When a new activity is authorized, if the additional funds to support it are not directly available from the unappropriated income, Council shall say what activity shall be curtailed or suppressed to permit transference of the fund required to support the new activity. If the budget of expenses is to be reduced, the Council shall say what activity shall be curtailed or suppressed.

4 The Society shall hold four general meetings with expense chargeable to the Budget. A fee shall be charged to nonmembers for admission to general or technical sessions at the four meetings of the Society according to rules established by the Board on Technology. No payments will be made for rental of rooms for the holding of technical sessions.

5 Council meetings shall be held at the place and time of the Annual and Semi-Annual Meetings. Council representation within the Budget shall be provided for the other national meetings.

6 Within the provisions of the Budget, Vice-Presidents shall be expected to visit Sections and Student Branches and attend Student Branch Conferences in their Regions or arrange for visits by their representatives.

7 No travel allowance will be provided for Board and Committee Chairmen attending Council Meetings except upon special provision of Council or the Executive Committee.

8 Eight Regional Administrative Committee meetings will be held within the provisions of the Budget.

9 A Regional Delegates Conference will be held at the place of the Semi-Annual Meeting.

10 The Nominating Committee may hold a preliminary meeting at a place to be selected and a Selection Meeting at the Semi-Annual Meeting within the provisions of the Budget.

Combined Analysis of Expenditure Budget 1955-1956

	Under Committee Supervision					
	Direct Expenditures	Joint Bodies	Members' Travel	Printing and Distribution	Office Expense	Total
PUBLICATIONS, STANDARDS, CODES, AND RESEARCH						
Mechanical Engineering text pages (excluding student copies)				$118,000.00	$ 53,092.00	$ 171,092.00
Mechanical Engineering adv. pages (excluding student pages)				175,100.00	155,436.00	330,536.00
Transactions (including *Journal of Applied Mechanics*)	$ 1,000.00				40,702.00	41,702.00
Membership List				10,000.00		10,000.00
"Know Your Society" (organization charts)				1,000.00		1,000.00
ASME Catalog				54,000.00	31,212.00	85,212.00
Publication Sales (except standards, codes, and research reports)				166,100.00	25,984.40	192,084.40
Standards and Codes		$ 1,000.00		95,000.00	102,502.33	198,502.33
Research				4,700.00	18,458.27	23,158.27
GENERAL SOCIETY ACTIVITIES						
Society meetings (including publicity)	57,000.00				23,323.00	80,323.00
Sections (including Regional Administrative Committee of Regional Delegates Conference)	85,000.00		$18,300.00		24,231.00	127,531.00
Professional Divisions	18,000.00				19,014.00	37,014.00
Student Branches (including copies of Mechanical Engineering text and advertising pages)	8,900.00		7,600.00	35,000.00	14,437.00	65,937.00
Admissions					22,735.00	22,735.00
Development					9,101.00	9,101.00
Awards	1,200.00				2,173.00	3,373.00
Civic Affairs Committee	500.00					500.00
GENERAL SOCIETY ADMINISTRATION						
Council and President	3,300.00		10,000.00			13,300.00
Professional Services	8,000.00					8,000.00
Nominating Committee			2,500.00			2,500.00
Retirement Fund	53,500.00					53,500.00
JOINT ACTIVITIES						
Engineering Societies Library		16,900.00				16,900.00
Engineers' Council for Professional Development		3,480.00				3,480.00
Engineers Joint Council		6,000.00	200.00			6,200.00
Engineering Societies' Personnel Service, Inc. (reserve)		500.00				500.00
Registration (National Council of State Boards of Engineering Examiners)		500.00				500.00
UET Pension Fund		4,000.00				4,000.00
Council for International Progress in Management		500.00				500.00
INDIRECT EXPENSE						
Secretary's Office					94,420.00	94,420.00
Accounting Department					55,932.00	55,932.00
General Service (stores, mailing, filing, etc.)					108,550.00	108,550.00
General Office (rent, insurance, etc.)					66,119.00	66,119.00
TOTAL	$236,400.00	$32,880.00	$38,600.00	$658,900.00	$867,422.00	$1,834,202.00

11 The following uniform basis of contribution toward travel expense shall be adopted.

(*a*) For meetings of the Council, the Vice-Presidents (when meeting at some other time and place than the Council), the Nominating Committee, the Regional Administrative Committees, and the Regional Delegates Conference.

Thirteen cents per mile one way (calculated by standard railroad route) plus $6 per day or major part thereof for time engaged in business at meeting and for trips over 100 miles for travel time to and from the meeting not to exceed round-trip travel time by standard railroad route.

These payments will be made upon submission of a report on a form supplied by the Secretary.

(*b*) For Student Branch Conference: 20 cents per mile for each Student Branch Delegation, including the faculty adviser. Student delegations under this provision may consist of (1) the faculty adviser, (2) the faculty adviser and at least one student delegate, or (3) one or more student delegates.

(*c*) Visits of Presidents and Vice-Presidents or their designated representatives to Sections, Branches, and the like, out-of-pocket expense within budgetary limits prescribed.

12 Payments to the Sections for operation shall be on the basis of the Standard Formula plus 25 per cent.

The Standard Formula is: $3.50 per member for the first 75 members, $1.50 per member for the next 425, $1.25 per member for the next 500, $1.00 per member for all over 1000, and $150 to each Section for each authorized Subsection.

Supplementary payments equal to one third of a dollar for each paid-up member in the Section on September 30, this supplementary payment to be made only on a specific request from the Section showing necessity for it, and with the approval of the Vice-President, the additional payment to be made with the second payment to the Section.

Any payments to a Section in addition to those paid on the Standard Formula shall require authorization by the Council.

Payments by the Section shall be made in accord with the Sections Operation Manual, and the Secretary's staff has authority to deny reimbursement for payments not so made.

13 Payments to the Student Branches for operation shall be on the basis of: 15 through 50 Student Members, $25; for the next 50 Student Members, 50 cents per Student Member; and for all over 100 Student Members, 25 cents per Student Member.

14 Grants of Society funds for Section, Division, and Student Branch operations shall not be used for social events.

15 The Society shall have two representatives on the American Standards Association.

16 No publications shall be printed for sale unless there is reasonable assurance of sufficient orders to pay for the cost.

Actions of ASME Council at Semi-Annual Meeting, Boston, Mass., June 19–20, 1955

THE Council of The American Society of Mechanical Engineers met in six sessions, two of which were executive sessions, on June 19 and 20, 1955, during the ASME Semi-Annual Meeting, Statler Hotel, Boston, Mass. David W. R. Morgan, President of the Society, presided. The following actions are of general interest.

Distinguished Guests at Council Luncheon. At a Council luncheon on Sunday, June 19, the President and Secretary of The Institution of Mechanical Engineers and the Secretary of the Danish Society of Engineers were guests.

Following the luncheon, President Morgan referred briefly to the co-operation between the IME and ASME, after which Percy L. Jones, president, and Brian G. Robbins, secretary of the Institution, responded. Mr. Robbins introduced Kenneth H. Platt, assistant secretary of IME, who had been in the United States since April studying engineering-society administration and engineer training. Secretary Davies expressed to Mr. Jones and Mr. Robbins the appreciation of the ASME staff for the opportunity to become acquainted with Mr. Platt and stated that this acquaintanceship will be of great future value in developing greater co-operation.

President Morgan then introduced Ove Guldberg, secretary of the Danish Society of Engineers, the host body of the Conference of Engineering Societies of Western Europe and U. S. A. (EUSEC) in Copenhagen, Denmark, Sept. 5–10, 1955. Mr. Guldberg presented, as a special token of appreciation to ASME on its 75th Anniversary, a ceramic plaquette in blue and gold depicting Prometheus, the Titan who stole fire from the gods and gave it to man. The plaquette is a small-scale reproduction of the decoration on the wall of the meeting hall of the Danish Society. President Morgan accepted the gift on behalf of the Society.

Budget, 1955–1956. The Council voted to approve the statement of policies and the budget for 1955–1956. (See pages 750–751.)

Constitution and By-Laws. It was voted to adopt amendments to Article B6A, Pars. 12 and 18 (Boards and Committees), of the By-Laws which received first reading Nov. 28–29, 1954; to receive for first reading proposed amendments to the following By-Laws: Articles B6A, Pars. 7 and 19 (Boards and Committees), B6B, Par. 11 (Society representation), B7, Par. 21 (Election of Officers and Directors), B11, Par. 9 (Sections), and B14, Par. 8 (Funds); and to confirm letter-ballot approval of adoption of amendment to Article R12, Rule 1 (Student Branches). It was also voted to approve the following interpretation of Article C7, Section 4, and Article B7, Par. 21:

> "In determining the length of past service of Directors and Vice-Presidents for the purpose of establishing their eligibility for re-election as members of the Council, the word 'term' or 'terms' shall be construed to mean 'full term' or 'full terms,' and any interim period or periods of service on the Council by a Vice-President or Director to fill a vacancy shall be disregarded."

Honorary Members Elected: The following Honorary Members of the Society were unanimously elected:

Joseph Bradley Armitage, Milwaukee, Wis.
James Harold Doolittle, New York, N. Y.
Samuel Broadus Earle, Clemson, S. C.
Simes Thurston Hoyt, Honolulu, Hawaii
Carl George A. Rosen, Peoria, Ill.
Clyde E. Williams, Columbus, Ohio

Membership Development. A report covering procedure for membership development which recommended a seven-step program was reviewed and approved.

Policy on Education. The Executive Committee, at its meeting on April 18, 1955, approved the report of the Committee on Society Policy on Education of Mechanical Engineers which was referred to the Board on Education and Professional Status. (See MECHANICAL ENGINEERING, June, 1955, pp. 562–563.) The Board on Education and Professional Status, on May 26, 1955, referred the report of the Society Policy Committee to the Education Committee with the following action:

> That the problem (education of mechanical engineers) be transmitted to the Education Committee with the statement that it is not the Board's understanding that "aggressive leadership" means superseding in any way the present activities of Engineers' Council for Professional Development but does imply strengthening and intensifying ECPD's work within the scope of ASME activities.

Pressure-Vessel Research. Approval was voted of a contribution of $600 (to be taken from the A-Development Fund) to the Welding Research Council for support of the work of the Pressure Vessel Research Committee.

Agreements Between Architects and Engineers. A standard form of agreement between architect and engineer was approved and adopted.

Research on Properties of Steam. The Research Committee on Properties of Steam has established and approved a program for research on steam properties, and has estimated that the total cost will be between $375,000 and $500,000. The Committee is seeking contributions from American industries at an annual rate of $125,000 for at least three consecutive years and substantial promises have been received.

In order to permit the program to get under way as soon as possible, the Council voted to authorize the advance of $10,000 to the Research Committee on Properties of Steam from the B-Development Fund for its research program on steam properties, with the understanding that this amount will be returned to the Development Fund when the funds which have been pledged begin coming in in the fall of 1955.

Initiation Fees. The Council accepted the recommendation of the Committee on Study of Initiation Fees that no change be made in the schedule of initiation and transfer fee as given in Section 1 of Article C5 of the ASME Constitution, and that agreements similar to that between ASME and AIEE be established.

Meetings in Regions VII and VIII. In order to build up the Hawaii Section, a meeting of the

Regional Administrative Committee at Honolulu in 1956 has been proposed. To meet the expense of this meeting the Council voted to set aside from 1954–1955 net income $2500 to be held in reserve, subject to written acceptance of 80 per cent of the delegates who would participate.

It was reported that at the Administrative Committee meeting of Region VIII, April 24, 1955, it was voted to discontinue the present practice of holding annual meetings within the Region.

ASME-EIC International Council. The present agreement between ASME and The Engineering Institute of Canada (See MECHANICAL ENGINEERING, December, 1951, page 1034) was amended by adding the following paragraphs:

The Council of The American Society of Mechanical Engineers and the Council of The Engineering Institute of Canada by identical action have agreed upon this provision by which a member of one of the two Societies may become a member of the other without payment of initiation or entrance fee in the other Society. In each case, the member of one Society must present an application for membership in the other Society and meet the membership requirements of that Society.

The elimination of entrance fee in the second Society shall apply only to the fee for entrance at the equivalent or lower grade. If an applicant to the second Society is upgraded by the second Society, his promotion fee shall be paid to the second Society. The Fellow grade in The American Society of Mechanical Engineers is upon nomination.

A Student Member of ASME who has transferred to the Associate Member grade of ASME upon graduation may apply for entrance as a Junior in EIC and upon acceptance may become a Junior in EIC without payment of the entrance fee in EIC.

A Student of EIC who has transferred to the Junior Grade of EIC may apply for entrance as an Associate Member of ASME and upon acceptance may become an Associate Member of ASME without payment of the initiation fee in ASME.

Sections. The name of the Green Mountain Section was changed to Northern New England Section, the territory to include the State of Maine. Establishment of the Shreveport Subsection of the Mid-Continent Section was authorized.

Certificates of Award. Certificates of Award were granted retiring chairmen of Region V committees: C. C. Womack (Sections Committee) and S. E. Babcock (Civic Affairs Committee); and to Waldemar S. Nelson, who served as chairman of the New Orleans Section in 1950.

Student Branch at Howard University. Establishment of an ASME Student Branch at Howard University was authorized.

New Engineering Societies Building. L. K. Sillcox, ASME representative on the Committee of Five Presidents, summarized the previous reports of the Committee and reported actions of the other societies.

Following Dr. Sillcox's presentation, each member of the Council in order was asked to raise any questions that seemed pertinent to the report of the Committee of Five Presidents. Dr. Sillcox responded. After this discussion, the Council considered a communication signed by 21 individuals and transmitted by Mervin J. Kelly on June 10, 1955, which suggested that a new study be made of the subject and offered assistance in financing such a study. The Council also reviewed the actions taken by the four other societies and after comprehensive discussion voted:

(*A*) That the majority and minority reports dated April 3 and 4, 1955, of the Committee of Five Presidents be received with thanks;

(*B*) That a Joint Task Committee of 20 members be organized, the members to consist of the members of the Committee of Five Presidents with each member empowered to appoint an alternate as needed, the members of the United Engineering Trustees, Inc., and three members to be appointed by the American Institute of Chemical Engineers, none of whom is an employee, with all voting in such Task Committee to be by each Society as a unit;

(*C*) That the Joint Task Committee be charged with the duty of recommending a location for the Engineering Societies Center based upon a review and comprehensive additional study of feasible locations;

(*D*) That the Joint Task Committee report simultaneously to the governing boards of the five societies as soon as possible but not later than Jan. 1, 1956, and the Joint Task Committee be directed to ask that the offer from Pittsburgh be extended to March 1, 1956;

(*E*) That the President of United Engineering Trustees, Inc., be asked to convene a meeting of the Joint Task Committee as soon as possible;

(*F*) That the Joint Task Committee be empowered to select its own chairman and to employ a paid secretary and to engage independent professional consultants to investigate the problem and to report their findings with recommendations to the Committee;

(*G*) That the sum of $75,000 be appropriated jointly by the five societies to finance the activities of the Joint Task Committee, with financial participation by ASME authorized here contingent upon acceptance of this plan by ASCE, AIEE, AIME, and AIChE;

(*H*) That the Joint Task Committee be empowered at its discretion to take advantage of the offer as indicated in the letter signed by 21 individuals, transmitted by Mervin J. Kelly on June 10, 1955;

(*I*) That the Council record its appreciation of the interest and substantial offers of assistance that have been received from various civic groups.

Joint Awards. The Secretary reported the 1955 recipients of joint awards as follows:

Gantt Medal, Walker L. Cisler, Detroit, Mich.
Elmer A. Sperry Award, William Francis Gibbs, New York, N. Y.

1955 Regional Delegates Conference. Allen H. Jensen, Speaker of the 1955 Regional Delegates Conference, presented the recommendations of the Conference on June 19–20. The Council voted to extend appreciation to the Regional Delegates for their painstaking work, to receive the report, and to refer the recommendations to the Committees concerned for report to the Council.

Presidential Appointments. The following appointments on committees were approved:

Air Pollution Controls Committee: Louis A. Winkelman, Mechanical Plant Engineer, Public Service Electric & Gas Company, Newark, N. J.

Lectureship Committee: Dana Young, Dean of Engineering, Yale University, New Haven, Conn., and Carl J. Eckhardt (Representative from Region VIII), University of Texas, Austin, Texas.

Research Committee on Furnace Performance Factors, R. A. Baker, Assistant to Mechanical Engineer, Public Service Electric & Gas Company, Newark, N. J.

150 U. S. Firms and Organizations to be Represented in Exhibits at Geneva Conference

SOME 100 U. S. industrial and commercial firms, along with 50 academic, professional, and private educational and research organizations, will be represented in exhibits at the International "Atoms-for-Peace" Conference at Geneva, Switzerland, August 8–20. Several commercial concerns will have displays in more than one of the exhibits.

So announcing Lewis L. Strauss, Chairman of the U. S. Atomic Energy Commission, said that this constituted "vivid evidence of the partnership of government and private enterprise in developing peaceful uses of atomic energy."

Eighty-three firms and organizations have contributed to the official U. S. technical exhibit at the Palais des Nations, site of the United Nations' sponsored conference. Another 19 have furnished parts of a United States Information Agency "teaching" exhibit at Geneva's exposition hall. At least 22 industrial and commercial firms will show independently or under private auspices at an atomic "trade fair," also to be located at the downtown exposition hall.

Fourteen commercial publishers and approximately 30 scientific, engineering, and other professional organizations will be represented in a display of more than 100 U. S. periodicals in the nuclear-energy field.

A 10-kw operating research reactor of the "pool" type will highlight the U. S. official exhibit. In addition, there will be ten scale models of power and research reactors operating or planned in the United States.

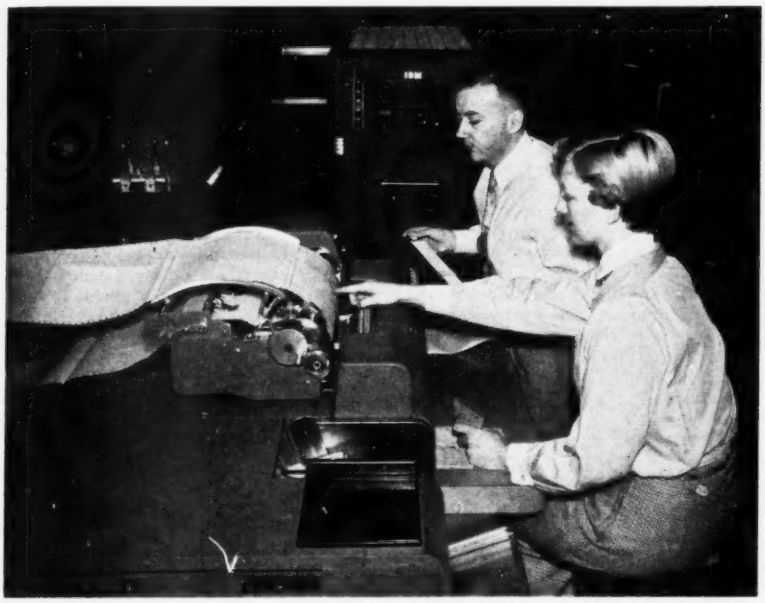
Other displays in the technical exhibit will show medical, biological, agricultural, and industrial applications of atomic energy, including uses of radioisotopes; a simulated reactor control panel; examples of reactor fuel elements and reactor components; a demonstration of chemical-separation techniques for atomic-waste products; and radiation measuring and other instruments.

The exhibit will be supplemented by a technical reference library containing several thousand AEC unclassified reports.

MECHANICAL ENGINEERING is among the periodicals to be exhibited. A Glossary of Terms in Nuclear Science and Technology, an ASME publication, will also be displayed.

Junior Forum . . .

Conducted by R. A. Cederberg,[1] Assoc. Mem. ASME



Author and technician checking solution to shifting-time problem as given by card-programmed calculator

The Young Mechanical Engineer in Industrial Research

By Raymond E. Holthe[2]

Introduction

TURBOSUPERCHARGED tractors with higher power and lower-fuel consumption, cars powered by 300-hp gas turbines, the vast power potential of the atom—all these have been, or will be, the result of industrial research. This paper will describe my work as a young research engineer in the earth-moving-equipment industry, and it is written with the hope that other young engineers, both in and out of college, will gain an insight into the problems, goals, and rewards of industrial-research work. The material will be presented as follows:

1 Orientation required in the transition from college to industry.
2 Example of a typical research assignment.
3 Value of basic engineering subjects taught in college.
4 Summary.

Orientation

In school we all, to a great extent, must solve our problems alone. Asking other students for help, especially during exams, is definitely frowned upon. Industry takes the exact opposite view—the young engineer is encouraged to ask more experienced men for help in completing his assignment. Thus getting along with others, of different ages and professional standing, becomes the first step in orientation. A company training program, where the young engineer meets all types of people in many different kinds of work, is valuable in this respect.

The second step in orientation is learning not to judge others too critically if they seem to be doing things all wrong. There is usually a good reason why things are done a certain way. If mistakes are made it means that engineers in industry are, after all, human beings. Also, the young engineer should realize that his own ideas are not always best and that better ideas have preference, even if suggested by someone else.

The third step in orientation is the recognition that company products must be sold at a profit. To "always beat competition" requires constant product improvement and each engineer must regard this as his personal responsibility.

Primarily for the young engineer contemplating a career in research design, I will describe a typical assignment—its conception, methods of attack, and solution.

A Typical Research Assignment

Diesel engines in earth-moving work must have good lugging characteristics, that is, a high-torque rise from high to low engine speed when under load. One way to get this high-torque rise is to supply additional air when the engine is at low speeds so that more fuel can be burned. My assignment was to design a supercharging system which would supply normal air requirements at high engine speeds and extra air at low engine speeds.

Since I knew very little about supercharging, I first searched the literature in our research library. After becoming familiar with terminology and typical systems, my initial feeling of frustration disappeared and preliminary calculations and sketches began to fill my design notebook. Now I felt qualified to discuss the job with the staff engineers and designers in our company, who have had many years of experience solving similar problems. The advice these men gave helped a lot, especially in eliminating some of the impractical solutions of which I was so proud. Solutions which prove to be impractical seem to be quite easily conceived by the young engineer. Finally, the staff engineer, who was in charge of the job, and I agreed on a system which was to be completely designed. The system selected was a centrifugal compressor, gear-driven from the engine by an automatic-shifting three-speed transmission.

Now that the assignment had been definitely pinned down, extensive calculations and sketches led to the final layout drawing. I had to return to the research library and to our company experts many times before the design was completed. As I did so, I realized the debt which the young engineer owes to those who so freely share their knowledge with him. Information obtained from others, however, is not all that is required for a new design. The transmission was to be shifted automatically in response to engine load, and designing the shifting mechanism required original creative thinking not found in any textbook. I have come to recognize the ability to do creative thinking as an essential requisite for successful research design. Creativeness can be learned, and the young engineer would do well to study the excellent material available if he is considering a research career.

Together with creative thinking, the research engineer must be able to translate physical problems into mathematical formulas. For example, the time delay while shifting the transmission was an important design factor as it determined the maximum load the engine could take before stalling. The shifting time was calculated by numerically integrating a formula derived from the physical elements of the supercharging system—the compressor rotor, planetary gear train, clutches, and hydraulic-shifting mechanism. The integration was performed on a card-

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[2] Design Engineer, Caterpillar Tractor Company, Peoria, Ill. Assoc. Mem. ASME.

ASME Membership as of June 30, 1955

Honorary Members	74
Fellows	404
Members	14,403
Affiliates	304
Associate Members (33 and over)	3,789
Associate Members (30–32)	4,499
Associate Members (to the age of 29)	15,964
Total	39,437

programmed electronic calculator which produced a solution in 15 minutes. If the calculator had not been used, the solution would have taken more than two days.

When the layout was completed and approved by the engineer in charge, a test model was made. This final part of the design required knowledge of drafting techniques, foundry practices, tolerances obtainable on the various machine tools, and assembly procedures. Again, I realized the value of our company training program which had given me experience in each of these fields.

Value of Basic Engineering Subjects

Which engineering subjects are most valuable in research work? Perhaps my best answer is to list those subjects which were used for the supercharging-system design described above:

1 Calculus
2 Differential equations
3 Machine design
4 Statics and dynamics
5 Strength of materials
6 Hydraulics
7 Fluid mechanics
8 Thermodynamics
9 Aerodynamics
10 English and report writing

For other jobs different subjects might be important, such as electricity or electronics. My advice to the reader is simple—make your knowledge of all engineering fundamentals as complete as possible. As a corollary to the value of engineering fundamentals, attendance at technical society meetings is also valuable. This is not in reference to a particular assignment but to that all-important part of industrial life mentioned earlier, "getting along with others."

Summary

I have tried to present industrial research as I see it—constant product improvement made possible by people with specialized knowledge working together as a team. The research engineer is granted a great deal of individual freedom to develop his own ideas, but he must learn to work with others and to benefit from their experience. Since each job is usually designed, manufactured, assembled, and tested in one area, he can follow his job closely and gain a well-rounded background which helps him in future assignments.

The research engineer must develop the ability to write accurate, interesting reports. A job cannot be considered completed until the report is written and reviewed by company executives. Like creativeness, writing good reports is more of a science than an art and should be mastered as early as possible.

Industrial research is particularly suited to the inquisitive person, one who is not satisfied with things as they are now, and who regards industrial competition as a stimulating challenge. For those who can meet these qualifications, research will provide rich rewards in professional recognition and personal satisfaction.

Engineering Societies Personnel Service, Inc.

THESE items are from information furnished by the Engineering Societies Personnel Service, Inc., in co-operation with the national societies of Civil, Electrical, Mechanical, and Mining and Metallurgical Engineers. This Service is available to all engineers, members or nonmembers, and is operated on a nonprofit basis.

In applying for positions advertised by the Service, the applicant agrees, if actually placed in a position through the Service as a result of an advertisement, to pay a placement fee in accordance with the rates as listed by the Service. These rates have been established in order to maintain an efficient nonprofit personnel service and are available upon request. This also applies to registrant members whose availability notices appear in these columns. Apply by letter, addressed to the key number indicated, and mail to the New York office.

When making application for a position include six cents in stamps for forwarding application to the employer and for returning when necessary. A weekly bulletin of engineering positions open is available at a subscription of $3.50 per quarter or $12 per annum for members, $4.50 per quarter for nonmembers, payable in advance.

New York
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Chicago
84 East Randolph St.

Detroit
100 Farnsworth Ave.

San Francisco
57 Post St.

Men Available[1]

Factory Manager and Chief Engineer, seeks staff position in metalworking industry; eight years' experience stamping and enameling industry; background in product application, development, design of special equipment, tools and dies, and factory management. Me-236.

Industrial Engineer, 37; BSIE; 13 years' experience, including 10 years' wage determination and labor standards. Desires consulting or administrative work preferably in East or South. Willing to travel. Me-237.

Management Trainee or Administrative Assistant, ME, Stevens, 1945. MBA, NYU, 1952, in management, accounting; eight years' experience administering work of technical committees. Single; 30; citizen. Will relocate; will travel. Me-238.

Sales Engineer, BSME, 32; family; six years' sales experience one of largest electrical and electromechanical manufacturers. Desires position in New England. Me-239.

Chief Engineer or Manager, 66, married, many years' experience in executive positions covering mechanical, civil, and marine engineering, licensed in three western states, well-qualified by personality and background to handle important assignments. Me-240-621. San Francisco.

Engineer—Attorney, 37; BME, MS in industrial and management engineering; registered patent attorney, seeks responsible position with progressive company where broad background can be put to effective use. Me-241.

Positions Available

Sales Trainees, under 32, graduate preferably mechanical, chemical, or metallurgical. Will be trained three months in laboratories and manufacturing plant, plus executive training. Then applicant will be placed in actual sales-contact work under direct supervision of senior salesman or sales manager, until he is ready for placement in field territory as a representative marketing products to industrial concerns. Must be willing to locate anywhere in U. S. Salary open. Pa. W-1326.

Engineering Draftsman, about five years' layout and detail of instruments and close-precision electromechanical devices. $6136. New York, N. Y. W-1623.

Inspector, graduate mechanical to take charge of the installation of machinery and mechanical equipment to be installed in new plant according to plans and specifications. $6500–$7800. Duration about eight months. Northern N. J. W-1624.

Sales Engineer, graduate mechanical or electrical, 28–35, experienced in engineering design, construction, maintenance, and practical plant operation. Must be able to work closely with customers' engineering and operating personnel. Equipment sales in field on bag filling and other packaging and materials-handling equipment. $4800–$7800. East. W-1626.

Assistant or Associate Professor, MSME, at least two years' experience in teaching. Will teach strength of materials, fluid mechanics, laboratory, and thermodynamics. About $4000, nine-month year. Fla. W-1634.

Engineers. (*a*) Project Engineer, mechanical graduate, make design calculations and follow design projects through engineering, experimental, and production phases. (*b*) Experimental engineer, test truck and bus-chassis components and new designs, supervise construction of pilot models. Previous automotive experience desirable. Recent graduates considered. To $7000. Pa. W-1652.

Time-Study Engineer, graduate mechanical, considerable time-study experience in the needle trades, for lined-suit division of company. Salary open. Pa. W-1653.

Junior Draftsman and Designer, mechanical-engineering background, capable of making equipment layouts and drawings; experienced in wire and cable manufacturing equipment. W-1658(*a*).

Draftsman, mechanical-design work. Must have some experience in home-radio receivers. $6500. New York, N. Y. W-1659.

Plant Engineer, 30–45, mechanical, experience in dairy or food-processing industry covering industrial boiler plant, processing machinery, refrigeration, and general building maintenance. Some traveling to plants in N. Y. State. $6000–$8000. Newark, N. J., area. W-1667.

Production Engineer, industrial or mechanical graduate, at least five years' time-study, production, and methods-analysis, including MTM experience in textile-cutting and sewing fields. $7500. Western N. Y. W-1678.

Engineers. (*a*) Chief design engineer, mechanical graduate, 32–42, at least ten years' equipment experience covering sheet-metal products and controls. $6000–$8000. (*b*) Draftsman, mechanical training and experience for layout

[1] All men listed hold some form of ASME membership.

(*ASME News continued on page 756*)

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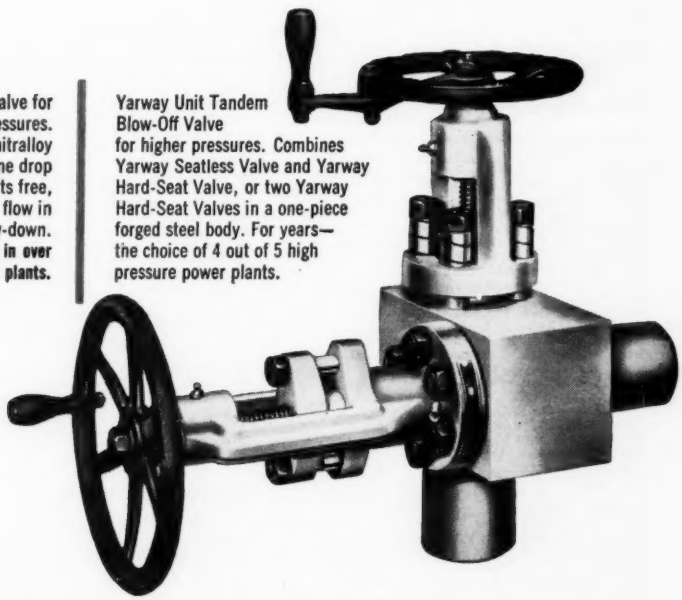

Yarway Unit Tandem Blow-Off Valve for higher pressures. Combines Yarway Seatless Valve and Yarway Hard-Seat Valve, or two Yarway Hard-Seat Valves in a one-piece forged steel body. For years—the choice of 4 out of 5 high pressure power plants.

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and detail of mechanical equipment. $3900–$5200. Newark, N. J., area. W-1682.

Instructor to Associate Professor, for mechanical-engineering department, to teach in the general fields of heat power and mechanics. Rank and salary dependent on education and experience. South. W-1687.

Senior Development Engineer, mechanical-engineering graduate, for research and development work. Should have ten to 20 years' experience in designing and development of heavy machinery, rolling mills, and hydraulic presses. $10,000 or more. Western Pa. W-1693.

Sales Engineer, 35–45, graduate mechanical, five years' sales experience; knowledge of hydraulics, to take charge of all sales activities. Considerable traveling. $7500–$9000, plus commission. Conn. W-1696.

Project Engineer, mechanical graduate, at least ten years' design experience on steam-power plant surface condensers. $8000–$10,000. N. J. W-1705.

Sales Engineer, 28–40, mechanical or electrical, at least four years' experience in aircraft servo-control engineering, test instrumentation, engineering, missile-control design, or similar work to sell aircraft instruments. $7500–$10,000, plus sales-incentive plan. New York, N. Y. W-1712.

Assistant Editor, BSME, a few years' experience in petroleum or chemical company and some experience in technical capacity with petroleum refining, petrochemical manufacturing, or natural gasoline recovery. Some report-writing experience. Salary open. New York, N. Y. W-1728.

Design Draftsman, mechanical-engineering training and experience on instruments, controls, and electronic devices. Must be citizen. $5200–$6500. New York, N. Y. W-1736.

Instructor, mechanical-engineering department, to teach mechanical subjects especially heat power. Salary open commensurate with experience and rank. New York, N. Y. W-1740.

Director of Engineering, 45–55, mechanical graduate, engineering and administrative experience supervising design, development, and application of aircraft, automotive, and industrial equipment and accessories. $20,000–$25,000, plus bonus. East. W-1754.

Production Superintendent, mechanical or chemical graduate, process-plant experience, about 30, five years' experience, with aptitude for process-plant operations and/or engineering supervision. Will engage in orientation program in general manufacturing. $6600–$8000. San Francisco Bay area. S-197.

Director of Research, mechanical or chemical engineering, 35–45, three years' experience supervising design and development of small precision-type items of metal or plastics, for supervising development of diversified new products of metal or plastics. $9000–$11,000. Ill. C-3188.

General Manager, 35–45, at least five years' experience in engineering and production work of high-volume small items. Knowledge of plastics or stampings, for supervising engineering and production work in plastics and metalworking high-volume small items. $11,000–$13,000. Ill. C-3189.

Plant Superintendent, 35–45, three years' experience in vacuum-forming products and preferably plastics. Will take charge of production on vacuum forming of plastics products for handbag manufacturer. $8000–$10,000. Ill. C-3211.

Project Engineer, 25–45, two years' experience in designing concrete structures, mechanical structures, or similar lines. Knowledge of applied mechanics helpful, to do drafting and design of product, machinery, concrete, or structural work, and other assignments. To $7200. Calif. C-3321.

Candidates for Membership and Transfer in the ASME

The application of each of the candidates listed below is to be voted on after Aug. 25, 1955, provided no objection thereto is made before that date and provided satisfactory replies have been received from the required number of references. Any member who has either comments or objections should write to the Secretary of The American Society of Mechanical Engineers immediately.

New Applications

For Member, Associate Member, or Affiliate

ABNETT, WILLIAM J., Philadelphia, Pa.
ACOSTA DE LA VEGA, JUAN, Mexico, D. F., Mex.
ALAIMO, ALFONSO F., Brooklyn, N. Y.
ANGELO, JOHN, Whippany, N. J.
BAZOW, JOHN T., Olean, N. Y.
BEAUBIEN, STEWART J., Oakland, Calif.
BENTZINGER, HARLAN A., Attleboro, Mass.
BERGEN, JAY H., Greenwich, Conn.
BIRGLER, RICHARD H., Larchmont, N. Y.
BLOSE, THOMAS L., Houston, Texas
BRAUN, HOWARD E., Schenectady, N. Y.
BRIDGEMAN, OSCAR C., Bartlesville, Okla.
BRONWELL, ARTHUR B., Worcester, Mass.
BROWN, GEORGE B., Sacramento, Calif.
BUTLER, JEROME M., Schenectady, N. Y.
CASE, RICHARD Y., Philadelphia, Pa.
CRAMB, DOUGLAS G. Toronto, Ont., Can.
CRIST, GEORGE E., Baytown, Texas
DAY, ANON D., Sr., Augusta, Ga.
DENTRAVGUES, JEAN, San Jose, Calif.
DESMOND, ALLEN L., San Francisco, Calif.
DILL, WALTER A., Duluth, Minn.
DINKINS, MERLE L., Shawnee, Okla.
DUNCAN, THOMAS E., Aiken, S. C.
DUNHOLTER, RUSSELL, Cincinnati, Ohio
FORBES, JOHN A., Youngwood, Pa.
FOX, WILLIAM G., New York, N. Y.
GASKELL, VERNON G., Youngwood, Pa.
GERDTS, HANS F., Cartagena, Colombia, S. A.
GOLZE, ROY R., Chatham, N. J.
GREGOR, TIBOR P., Toronto, Ont., Can.
GRIFFITH, JAMES D., Omaha, Neb.
GRIFFITHS, WILLIAM T., JR., Charleston, W. Va.
GULINO, ROSARIO, Groton, Conn.
HABLEY, CHARLES G., Atlanta, Ga.
HARTLEY, DONALD, St. Joseph, Mich.
HAY, ERROLL B., JR., Atlanta, Ga.
HEINES, JEAN M. H., Amherst, Nova Scotia, Can.
HIGMAN, MERVYN B., Jackson, Miss.
HIPSHIRE, WILLIAM H., Dayton, Ohio
HORNFELT, HARVEY A., Toronto, Ont., Can.
HUGHES, DONALD E., Schenectady, N. Y.
JAMES, RALPH, JR., Channelview, Texas
KENYON, CHARLES H., Corning, N. Y.
KNARR, PAUL L., Tonawanda, N. Y.
KRAMER, ALEXANDER E., Washington, D. C.
KUBIK, FRANK S., Michigan City, Ind.
LABRIQUE, JACQUES E., Angleur, Belgium
LECHNER, ALFRED, Groton, Conn.
LEE, CHESTER E., Bartlesville, Okla.
MACDUFF, EDWARD J., Wellsville, N. Y.
MALONE, RAYMOND A., Olean, N. Y.
MATTHEWS, JAMES B., Dumas, Texas
MCCARTHY, LAWRENCE A., Haverhill, Mass.
MITCHELL, EARL R., Ottawa, Ont., Can.
PANARO, MODESTO C., Union, N. Y.
REESE, STANLEY O., Jacksonville, Fla.
RESSLER, CLARENCE J., Carlisle, Pa.
RICE, JULIAN B., New York, N. Y.
SAMPSON, JOSEPH, Cincinnati, Ohio
SAPORITO, VINCENT J., Brooklyn, N. Y.
SCHILLING, ARTHUR R., North Plainfield, N. J.
SCHWARZBECK, JOHN G., Los Angeles, Calif.
SLATER, GEORGE G., Weston, Ont., Can.
SNYDER, ARTHUR I., Oakland, Calif.
STILLMAN, LEE P., Tulsa, Okla.
STINSON, JOHN A., Jensen Beach, Fla.
TABER, THOMAS T., Wellsville, N. Y.
TABOLT, GERALD S., Olean, N. Y.
THOMPSON, ROBERT T., Milwaukee, Wis.
TRAWICK, JACK G., Birmingham, Ala.
VAN GILSE, WILLIAM V., Cincinnati, Ohio
WILLKE, HERBERT L., Toledo, Ohio
WOLPE, JOSEPH M., St. Louis, Mo.
ZAHAVI, ELIAHU, Haifa, Israel
ZELISKO, MICHAEL, Chicago, Ill.

Change in Grading

Transfers to Member or Affiliate

COHN, GUNTHER, Philadelphia, Pa.
GRIM, KENNETH H., New York, N. Y.
HETTINGER, CARL F., Baltimore, Md.
HOFFER, ARNOLD H., Erie, Pa.
KING, DONALD L., Salt Lake City, Utah
LEVY, MARVIN B., Philadelphia, Pa.
ROBERTS, JOHN A., Davenport, Iowa
SIMPSON, JAMES W., Buffalo, N. Y.
SPAET, ARTHUR, New York, N. Y.
SUBRAMANIAM, PALLAVOOR S., Boston, Mass.
TATE, ROBERT L., Baltimore, Md.
WOOLF, JACK R., Fort Worth, Texas
WORLEY, CLAUDE B., JR., Glen Cove, N. Y.
ZAPP, FRANK C., Oak Ridge, Tenn.

Transfers from Student Member to Associate Member 300

Obituaries . . .

Walter Charles Baker (1868–1955), retired consulting engineer, Cleveland, Ohio, died April 26, 1955. Born, Hinsdale, N. H., June 27, 1868. Parents, George W. and Jeanette R. (Hall) Baker. Education, graduate, Case School of Applied Science, 1891. Married Fannie E. White, 1891. In 1940 he received a Distinguished Service citation from Automobile Old Timers, Inc. Mem. ASME, 1919. Survived by wife; daughter, Mrs. Harold B. (Elizabeth) McKelvey, Miami, Fla; and Robert W. Baker, Aptos, Calif.

William Felton Barrett (1886–1955), industrialist and director of many corporations, died at Doctors Hospital, New York, N. Y., May 24, 1955. Born, Dayton, Ohio, March 15, 1886. Parents, James H. and Catherine (O'Neil) Barrett. Education, PhB, Sheffield Scientific School, Yale University, 1904; hon. DS, University of Pittsburgh, 1925. Married Margery Barker, 1911. Mem. ASME, 1915. For 32 years he was connected with Linde Air Products Company; president, 1925–1929; chairman of the board, 1929–1944. He was vice-president and chairman of the board of the Union Carbide and Carbon Corporation from 1926–1944. He had been on the boards of various other companies. Survived by wife; three sons, Julian S., William F., and David B.

Carle Muzzy Bigelow (1889–1955), retired assistant to the general manager, American Cyanamid Company's fine chemical division, died May 10, 1955. Born, Woonsocket, R. I., Dec. 22, 1889. Parents, Erwin E. and Mary M. (Willis) Bigelow. Education, BS, Rhode Island State College, 1912; ME 1921; hon. DS, Suffolk University, 1941. Married Olive Nicholson, 1914 (deceased). Married 2nd, Maude E. Gotcher, 1935. Jun. Mem. ASME, 1917; Assoc-Mem. ASME, 1918; Mem. ASME, 1921. Author of numerous technical papers on management and pharmaceuticals. Survived by wife; three children by his first marriage, Mrs. John R. Burkett, Mrs. Richard Liebert, and Erwin S.; and six grandchildren.

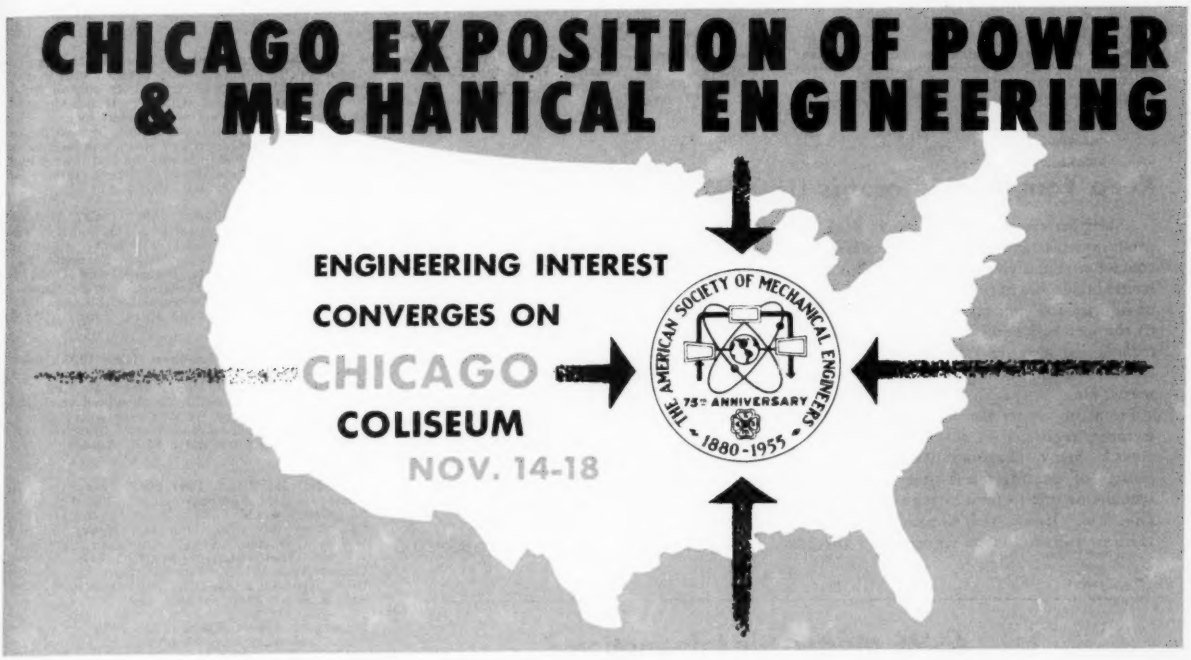
William Hamilton Chaffe (1884–1955), retired engineering consultant, Simmons Co., Elizabeth, N. J., died April 26, 1955. His home was in Torrington, Conn. Born, New Orleans, La., Oct. 25, 1884. Parents, John C. and Annie (Griffen) Chaffe. Education, ME, Tulane University. Married Pearl Manley, 1907; children, William H., Jr., Nancy (Chaffe) Zewere. Mem. ASME, 1922.

Albert J. Dexter (1879–1955), retired draftsman and machine designer. Formerly with U. S. Rubber Co., died at his home in Springfield, Mass., in April, 1955. Born, Ware, Mass., June 20, 1879. Parents, Joseph C. and Mary (Gibbs) Dexter. Education, high-school graduate; ICS. Married Miss Prindle, 1900. Author of many articles published in trade journals and held patents on a gas engine and sundry machine tools. Mem. ASME, 1920.

Gustav Egloff (1886–1955), research director, petroleum scientist and publicist, Universal Oil Products Co., Des Plains, Ill., died April 29, 1955. Born, New York, N. Y., Nov. 10, 1886. Parents, August and Mary (Schiller) Egloff. Education, BA, Cornell University, 1912; MA, Columbia University, 1913; PhD, 1915; hon. DS degrees, Polytechnic Institute of Brooklyn, 1938; Armour Institute of Technology, 1940; Philadelphia College of Pharmacy and Science, 1944. Married Clara Mellor, 1915. Held 300 patents on processing petroleum oil, coal, shale oil, and chemical derivatives hydrocarbons. He was the author of 650 articles on petroleum and the chemistry of hydrocarbons, particularly the cracking and refining of oil. He wrote such widely used reference books as "Thermal Reactions of Pure Hydrocarbons," "Catalysis," "Isomerization of Pure Hydrocarbons," "Alkylation of Alkanes," and the five-volume "Physical Constants of Hydrocarbons." He served as vice-president to four world power conferences; delegation to Congress for Automobile Transportation, Rome, 1928; World Engineering Congress, Tokyo, 1929; three world petroleum congresses; lectured before chemical symposium of Royal Institute of Chemistry, St. Andrews, Scotland, July, 1947; International Congress of Pure and Applied Chemistry, Rome, 1938; London, 1947; New York City, 1951, and many others. In his years as research director, the petroleum refining industry was revolutionized

(*ASME News continued on page 758*)

CHICAGO EXPOSITION OF POWER & MECHANICAL ENGINEERING



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through processes to which he made important contributions. Many honors had been conferred upon him at home and abroad. He was awarded the gold medal of the American Institute of Chemists, 1940; National Research Council's Distinguished Service Award, 1941; Octave Chanute Medal (1939–1940), Western Society of Engineers; "Modern Pioneer," National Association of Manufacturers, 1940; Columbia University Medal for Excellence, 1943; a fellowship in the British Royal Society of Arts, 1950; and in 1953, the Washington Award of the Western Society of Engineers. One of his most recent awards was the Karl Engler Medal, Germany's highest honor in mineral-oil science, which was given to him at Essen on Oct. 7, 1954. It was the first time it had been presented to a scientist living outside of Germany. Mem. ASME, 1940.

Norman James Elder (1917–1955?), whose death was reported recently to the Society, was sales manager, Calender Division, Adamson United Co., Akron, Ohio. Born, Carnegie, Pa., Aug. 15, 1917. Parents, James H. and Anna M. (Wilkinson) Elder. Education, BME, University of Akron, 1941. Married Irene Leona Yarger, 1941; daughter Jane Ellen. Jun. ASME, 1941.

John Frederick Johannsen (1886–1955), manager, Export Division, Hyster Co., Portland, Ore., died March 30, 1955. Born, Hawley, Pa., June 1, 1886. Education, high-school graduate; YMCA night classes; ICS; University of Southern California Extension Courses. Mem. ASME, 1942. Survived by wife, Mrs. Amelia B. Johannsen.

Russell H. Kent (1891–1955), executive engineer, Kent Manufacturing Co., Clifton Heights, Pa., died May 27, 1955. Born, Clifton Heights, Pa., Aug. 31, 1891. Parents, Henry T. and Louise (Leonard) Kent. Education, graduate William Penn Charter School; ME, Cornell University, 1912. Married Dorothy Curtis, 1914; children Russell H., Jr., Laurence S., Barbara B. Assoc-Mem. ASME, 1921.

Bernard Albert Klein (1891–1955), manufacturers' representative, Montclair, N. J., died Feb. 8, 1955. Born, New York, N. Y., Nov. 13, 1891. Parents, Philip H. and Katherine M. (Hemmeter) Klein. Education, BS(ME) McGill University, 1916. Assoc-Mem. ASME, 1924; Mem. ASME, 1935.

Charles Henry Masland, 2nd (1894–1955), vice-president, C. H. Masland & Sons., Inc., Carlisle, Pa., died April 9, 1955. Born, Ocean City, N. J., Aug. 3, 1894. Parents, Charles W. and Lissie (Lake) Masland. Education, graduate, Northeast High School; attended University of Pennsylvania. Married Beatrice M. Graham, 1918; children, Anne, Charles, Daniel, Martha. Mem. ASME, 1931.

John Posey Mudd (1888–1955), public-relations director, The Midvale Co., Philadelphia, Pa., died May 1, 1955. Born, Baltimore, Md., March 12, 1888. Parents, Francis E. and Mary Ella (Posey) Mudd. Education, BS(ME), Maryland Agricultural College, now University of Maryland, 1907; ME, 1910; attended Cornell University, 1908–1909. Married Mabel Frances Jones, 1909. Jun. ASME, 1910; Assoc-Mem. ASME, 1915; Mem. ASME, 1935. He served the Society as chairman, Philadelphia Section, 1921–1922; previously he had been secretary and vice-president. His hobbies won him recognition in the fields of photography and yachting. He took an active part in several civic organizations including the Industrial Relations Committee of the Chamber of Commerce of Greater Philadelphia and Friends of Franklin at The Franklin Institute. Survived by wife, three daughters, Mabel F., Caroline, and Mrs. George H. Ritzman, Jr.; and two grandchildren.

Herbert Edward Muenzer (1913–1955), designer, air-conditioning section, Douglas Aircraft Co., Santa Monica, Calif., died Feb. 14, 1955. Born, Lents, Ore., April 6, 1913. Parents, Mr. and Mrs. H. G. Muenzer. Education, BS(ME), Oregon State College, 1936. Mem. ASME, 1950. Survived by parents.

Maurice J. Plonsker (1895–1954), owner and general superintendent, Plonsker Engineering Co., Chicago, Ill., died Oct. 23, 1954, at his home in Winnetka, Ill. Born, New York, N. Y., Dec. 4, 1895. Parents, Herman and Toba Plonsker. Education, ME, Polytechnic Institute of Brooklyn, 1918. Married Miss Maremont, 1925; two sons, Ira, Assoc. Mem. ASME; and Harvey. Jun. ASME, 1917; Assoc-Mem. ASME, 1922; Mem. ASME, 1935.

Charles Deere Wiman (1892–1955), president Deere & Co., Moline, Ill., died May 12, 1955, at Tucson, Ariz. Born, Staten Island, N. Y., Feb. 11, 1892. Parents, William D. and Anne C. (Deere) Wiman. Education, Hill School, Pottstown, Pa.; PhB, Sheffield Scientific School, Yale University, 1914. Married Pattie Harris Southall, 1920; children Mary Jane D., and Patricia D. During World War II he served on the Farm Implements Branch, War Production Board. He received Legion of Merit, December, 1915.

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